GEOLOGICAL RECONNOISSANCE.

NOTE BY THE ADMINISTRATOR.

NOTWITHSTANDING the fact that the late lamented State geologist, Dr. D. D. Owen, dictated portions of this Report until within three days of his death, there yet remained fifteen counties, viz., Pike, Ouachita, Lafayette, Columbia, Union, Calhoun, Bradley, Ashley, Drew, Chicot, Arkansas, Jefferson, Crittenden, Mississippi, and Craighead, the recorded observations regarding which existed only in the form of field-notes, sufficiently extensive indeed, but frequently abbreviated, and merely suggestive.

The undersigned having, at the request of the family, taken out letters of administration on the estate of his deceased brother, it thus became his official, as well as it was previously a cherished fraternal duty to secure, as far as was consistent with the circumstances, the completion of the Report according to the original design.

Mr. E. T. Cox, who had for years been associated in this and other surveys with Dr. D. D. Owen, kindly undertook the preparation of those notes for the press, although the described counties had not been visited by him in person; and with the critical accuracy of Mr. J. P. Lesley, of Philadelphia, previously obtained to superintend the press and revise the proofs, h[illegible]ed doubly valuable, creditable accuracy may be relied on. To Mr. M. W. Smith sincere obligations are also due for the sheets written out by him from dictation, previous to the death of Dr. Owen, and for the arrangement of the field-notes before the arrival of Mr. Cox.

The above explanation, alike due to all parties, may secure from the public a lenient criticism, should there appear any discrepancy, omission, or want of amplification in the details of the above counties.

The administrator cannot close this notice without asking permission to record here the feeling, so often expressed by his deceased brother, regarding the promptness and liberality in business, as well as the courtesy and kindness in intercourse, evinced by his Excellency, E. N. Conway, late Governor of Arkansas, during the entire work and execution of the survey.

RICHARD OWEN,

Administrator on the Estate of Dr. D. D. Owen, deceased.

SECOND REPORT

OF A

GEOLOGICAL RECONNOISSANCE

OF THE

MIDDLE AND SOUTHERN COUNTIES

OF

ARKANSAS.

MADE DURING THE YEARS 1859 AND 1860.

BY

DAVID DALE OWEN,
PRINCIPAL GEOLOGIST,

ASSISTED BY

ROBERT PETER, Chemical Assistant;
M. LEO LESQUEREUX, Botanist;
EDWARD COX, Assistant Geologist.

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1860.

INTRODUCTORY LETTER.

To his Excellency, Elias N. Conway,

Governor of Arkansas.

Sir,—In conformity with the Act, approved 21st February, 1859, and under your reappointment, bearing date the 22d of February, 1859, I have continued the further prosecution of the Geological Survey of the State, and herewith submit my Second Geological Report of the results of the surveys made since the passage of that Act, which results are embodied in the following pages.

Very respectfully,

Your obedient servant,

DAVID DALE OWEN.

INTRODUCTION.

In the First Volume of the Arkansas Report, I have already set forth the objects and utility of a well-conducted Geological Survey.

The work which has been accomplished, is, as yet, only introductory to a thorough survey of the State, since, in reality, all that it was possible to complete from the commencement of the survey up to this time is a Geological Reconnoissance, or a general survey in advance of more detailed surveys of those regions which that Reconnoissance may designate as mineral districts: still, any one who will carefully and understandingly peruse these pages, must become convinced of the importance and value of even this rapid Reconnoissance.

The following are some of the leading practical results, summary conclusions, and general statements:

The knowledge of the general boundaries of the geological formations now established, enables the geologist to predict what valuable minerals may be found within their limits, and what it would be a useless waste of time to search for within the same.

The survey has also established the great geological axis and trend of the formations, which give not only the contour to the topographical features of the State, but a clue to the great synclinal folds or troughs, in conformity with which certain geological strata appearing, at one time, in elevated position in the mountain ranges, sink beneath the surface, to reappear, perhaps, in natural outcrop on the opposite side of some wide valley. Some of these basins have been proved to be the repository of salt; which may be brought to the surface through the intervention of Artesian brines.

The extent and area of the coal-bearing strata have been generally ascertained, their geological position established, and their leading chemical properties and composition tested.

Those districts have been pointed out which are most likely to afford

lead ore, and which, therefore, especially demand the attention of lead-miners.

Numerous iron regions have been discovered, many of which are well worthy the examination of the iron master, and the composition of many of these iron ores has been already ascertained by their chemical analysis, to be found recorded in their appropriate places.

Wide belts of country have been indicated where marble prevails.

Sources have been pointed out where the best limestones can be procured, both for burning to lime, making hydraulic cement, and for the improvement of land, as mineral fertilizers and physical ameliorators of the soil.

Localities have been pointed out where marls and potter's clays can be obtained, and their value will be shown hereafter by chemical analysis.

In the Agricultural Department of the survey, complete suites of soils have been collected, these being selected with great care and with special reference to the derivative geological formation, and with a view to settle that very important question, whether soil analysis can be of utility to the agriculturist, and whether it is capable of showing the relative fertility of soils, their peculiarities derived from different geological formations, and the loss sustained by cultivation.

Time, up to the present, has only permitted the completion of the analyses of one hundred and eighty-seven of these soils, subsoils, and underclays. An examination of these soil-analyses, together with three hundred and seventy-five, reported in the Kentucky survey, establishes, in my opinion, in the most incontrovertible manner, not only the great utility and practical importance of soil-analyses, but other facts, of the greatest interest, in connection with the subject of agricultural chemistry, to which I shall call particular attention in the agricultural section of this Report.

The medical and chemical properties of numerous mineral waters have been exhibited, either by *qualitative* chemical analyses made at the fountain head, or by *quantitative* chemical analyses made in my laboratory, giving the proportions by weight of the different ingredients in a certain weight of the waters; as, for instance, of the waters of the Hot Springs, White and Black River waters, &c.

Much valuable information has also been conveyed by the examination of many well and spring waters, showing their salubrity and fitness for domestic use.

The geological survey has also pointed out the origin and source of the Hot Springs; and explained the mode of formation, and designated also the age of two of the most interesting and beautiful minerals of the State, the Whetstone and Rock-crystal formations.

Until a minute detailed survey shall define all the plications of the strata, and establish systems of anticlinal and synclinal folds, it would be

impossible, in all instances, to give a precise opinion with regard to the success of Artesian borings throughout the State; but still enough has been ascertained on these points to give, in many cases, valuable information.

Though I have, myself, not actually seen one particle of gold in the State, yet I have no reason to disbelieve the statement of others, who assert that they have, at certain localities, found small flakes of that metal; and though I have not as yet seen either the *true* gold-bearing slate and quartz vein, still there is a large district of Arkansas occupied by metamorphosed slates, adjacent to granite; and as for quartz veins, I venture to state there are few countries, if any, in which there is such a wide, indeed, almost universal diffusion of milky quartz in veins, seams, and beds, as in many of the middle counties: and silex, in some shape or form, is everywhere diffused and disseminated: sometimes in the form of chert, hornstone, and chalcedonic flint; sometimes as burrstone: sometimes as hone and whetstones; sometimes as quartzose sandstone (in fact, so much so, that the tire of carriage-wheels will be almost worn through in travelling only a single season over the State); but the slates are less magnesian and talcose, and the quartz less ferruginous than is usual in most auriferous regions, and yet the surface symptoms so much resemble those of the gold regions of Georgia and North Carolina, that settlers from these States, at all acquainted with gold-washing, have generally been so struck with the "prospect for gold," that they have almost invariably been induced to attempt a search, but, so far as I have been able to learn, with little or no success. Yet, even if no gold should be found profitable to work, there are resources of the State in ores of zinc, manganese, iron, lead, and copper, marble, whet and hone stones, rock-crystal, paints, nitre-earths, kaolin, granite, freestone, limestone, marls, green-sand, marly limestones, grindstones, and slate, which may well justify the assertion, that Arkansas is destined to rank as one of the richest mineral States in the Union.

Her zinc ores compare very favorably with those of Silesia; and her argentiferous galena far exceeds, in percentage of silver, the average of such ores of other countries. Her Novaculite rock cannot be excelled in fineness of texture, beauty of color, and sharpness of grit.

Her Crystal Mountains stand unrivalled for extent; and their products are equal, in brilliancy and transparency, to any in the world.

Yet Arkansas is a young State; and her geological survey is, in reality, only fairly commenced. If thus early in this work we are able to report such flattering prospects, what may not be anticipated by thorough and minute detailed surveys?

A comparison of the analyses of her soils, as far as yet made, with a few soils collected in Iowa, Wisconsin, and Minnesota, shows that her soils, generally, are equally rich in fertilizing ingredients with those of the said

States; and that her best bottom lands are, in truth, richer,—facts admitting of an easy explanation, which will be given in the body of this Report.

It is true that, in the hilly and mountainous regions of Arkansas, the surface is much more broken and rocky than in Iowa, Wisconsin, and part of Minnesota. These States possess a wonderful advantage in their general levelness of surface, unobstructed, for the most part, by surface-rock; but this, in a measure, is counterbalanced by the shortness of the Arkansas winter and the abundance of timber.

To the general diffusion of silex, or more properly silicate of potash, in the soil of Arkansas, is probably to be attributed the almost universal growth of pine timber, not always, or, generally, as an exclusive pine forest, but intermixed more or less with other timber. So peculiarly indigenous does the yellow pine appear to be to the Arkansas soils, that you will even find it growing in river and creek bottoms, side by side with the gum, and on the argillaceous slopes, associated with beech.

Another peculiarity in the timber of Arkansas is the entire absence of poplar timber, with the exception of a luxuriant growth on the quaternary soils of Crowley's Ridge.

The Osage orange, or Bois d'Arc, seems to be particularly congenial to the cretaceous soils of the southwest counties, particularly of Hempstead County. It is an opinion advanced by Dr. N. D. Smith, of that county, that it is indigenous to the Red River country above the Great Raft. At all events I am convinced that the cretaceous soils, highly charged as they are with lime, are peculiarly adapted to its growth.

The Botanical Department, provided for in the Act of the 21st February, 1859, I intrusted to M. Leo Lesquereux. That gentleman, well known to science as an able, thorough, and experienced botanist, has also devoted himself to the study of fossil botany. His double acquirements rendered him peculiarly suited to the duty assigned him in Arkansas,—not only that of reporting on the recent botany of the State, but also of investigating its carboniferous fossil flora.

In the First Report, the opinion was advanced, that there was but one geological horizon of workable coal, and that that bed of coal belonged to the era of the millstone grit, having been formed previous to and lying beneath No. 1 coal of the sections of Kentucky.

This opinion was based chiefly on observations of superposition, *i.e.* on the relative position of the coals of Arkansas, with reference to the well known Archimedes and Pentremite-beds of the underlying sub-carboniferous limestone group, and the peculiar character of the overlying sandstones and shales.

The establishment of this fact, with reference to the Arkansas coals, being, in a practical point of view, amongst the most important problems in the geology of Arkansas, I was the more desirous to bring all the evi-

dence possible to bear on this subject. In particular, the investigation of the specific character of the fossil plants of the roof shales of coal, being regarded by many as supplying important data as to the exact age of different beds of coal, appeared to me indispensable, inasmuch as it involved a question which I deemed of so much moment to the future interests of Arkansas; while, at the same time, important facts might be developed in aid of the solution of a great scientific inquiry. No individual could be better prepared to enter on this investigation than M. Leo Lesquereux, since his previous long experience in the fossil flora of the coal fields of Pennsylvania and Kentucky had given him an insight into this special study, which no other man in this country possesses. His report on this subject will therefore be read with interest.

Unfortunately, neither the means at my disposal, nor the previous engagements of that gentleman, permitted me to engage his services but for a limited period of time; nevertheless, much has been accomplished, as from a previous knowledge of localities, I was able to plan his route, so that he might reach at once the coal outcrops, where he could make his observations on fossil botany to the best advantage; while along his line of travel he could, during the same excursion, explore the recent botany of the country. So far, however, his field surveys in Arkansas have necessarily been confined to a season not the most favorable to witness plants in their perfection, viz., October, November, and December. It was my intention that he should have made another survey in the spring of 1860, for the purpose of observing the plants of Arkansas at a time when many of them are in bloom; but his previous engagements prevented M. Lesquereux from accomplishing that design.

In the United States the people are already alive to the importance of the grape culture in a commercial and moral point of view; but, as yet, they are not aware of the extraordinary medical properties attributed to it in Europe. I would, therefore, call especial attention to M. Lesquereux's remarks on this subject in his botanical report.

After Dr. Elderhorst left for Europe, in the middle of February, 1859, I engaged the services of Dr. Robert Peter to make the analyses of the soils for the Agricultural Department of the survey. No man in the United States has had so large an experience in soil-analyses as Dr. Peter. During the progress of the Kentucky survey, he has analyzed three hundred and seventy-five soils; for the Indiana survey, he has analyzed thirty-three; and he has already completed, for the Arkansas survey, the chemical analysis of one hundred and eighty-seven soils. These analyses have been conducted upon the most approved plan, and with the utmost accuracy of which chemistry is at present capable; indeed, the extraction of the soluble portion of the soil, by long digestion in carbonic acid water, is a process

first suggested and carried out by Dr. Peter; and has never, to my knowledge, been applied to any other series of soil-analyses but his own. In the Agricultural section of this Report I shall endeavor to show the utility and practical importance of this great work. To these remarks I would emphatically call the attention of my readers; particularly of those sceptics and disbelievers who depreciate the value of such chemical researches, and even scout the idea of the chemical analysis of a soil conveying any information valuable to the farmer.

REPORT

OF A

GEOLOGICAL RECONNOISSANCE

OF PART OF THE

STATE OF ARKANSAS.

GEOLOGICAL RECONNOISSANCE.

CHAPTER I.

SINCE the publication of the First Report on this State, the Geological Reconnoissance has been extended over the middle and southern counties of Arkansas, completing the preliminary survey of the State.

When I speak of the Geological Reconnoissance of the State having been completed, let me not be misunderstood.

I mean by this that the leading geological features of the State have now been ascertained, and, consequently, a clue obtained to what may be expected to be found in the State within the limits of these various formations; the *general* boundaries of which may now be said to be established.

This is, however, in fact, only the preliminary step to the commencement of a regular *detailed* geological survey.

With the information now collected, though the general outline of the geological formations can now be laid down, the meanders and details of these boundaries can only be properly established after a correct topographical map shall have been constructed, showing the contour, by lines of equal altitude, of the principal ridges. This is a work of time and labor; but still one that can be accomplished with much greater facility in a State like Arkansas, which has been laid off into townships, sections, and quarter-sections, than in a State like Kentucky, where geographical maps must necessarily be constructed before one step can be taken towards establishing with precision the geological features of the State. Hitherto the State boundary lines, and a few of the larger rivers, have been the only recognized lines to aid the geologist in his work in Kentucky.

Since each geological formation has its peculiar mineral associates, the experienced geologist, once acquainted with the general areas of the geological rock-formations, knows what kind of mineral may be sought for in each with a prospect of success, and also those which it would be a useless waste of time to search for.

The fundamental knowledge, then, obtained by the preparatory general

survey, or, in other words, geological reconnoissance, is indispensable, since it not only enables the geologist to predict what *may* and what may *not* be found, but gives that general acquaintance with the geological features of the State, without which the geologist must be unprepared to direct detailed surveys with that degree of confidence and precision which the importance of such work demands.

Several rude attempts have been made to represent the geology of Arkansas on colored geological maps of the United States, constructed by individuals, none of whom ever visited the State of Arkansas, but who endeavored to gather their information from the writings or observations of others. All these attempts, as they do not give any correct idea of the course, area, or succession of the geological formations of Arkansas, must be considered failures, more especially, as they are all on too small a scale to represent the geology of the country, even if they had been correctly constructed.

The granitic* axis, which gives to Arkansas its peculiar geographical features, has greatly disturbed and modified its geological rock-formations, aided, undoubtedly, by a continuous wide-spread underground extension of these igneous rocks, on a platform of which the stratified rocks of Arkansas repose, at a greater or less depth, conforming to the contour of a waved surface.

The main southern granitic protrusion, to which I now more particularly allude, has not assumed an east to west bearing, as one would be led to suppose from an examination of these maps. That portion of it, exposed to view in Pulaski County, partakes of a crescent-shaped curve, the southern limb of which bears nearly north and south. Neither do these rocks occupy a surface-area nearly as great as has been represented.

But though its actual surface outcrop is only about four miles in length and two in breadth, on the waters of the Fourche, and about three to four miles in length in Saline County, and still less in Magnet Cove, in Hot Spring County, yet these distant protruded masses of igneous rocks have, undoubtedly, a continuous connection beneath the drainage of the country. A line connecting these different localities would, therefore, give the general bearings of the main granitic outburst of Arkansas, from northeast to southwest; although I believe, when the detailed geological survey of the State comes to be made out, the most prevalent strike-line of the *stratified* rocks will be found to be nearly east and west.

The great range and area of the metamorphosed shales, sandstones, and limestones, together with the numerous instances that will be hereafter cited of tilted strata, and high angles of dip, far removed from the axis

* By granitic, I here include not only granite proper, but the associate hornblendic and augitic rocks.

above described, can only be accounted for by proximity to a subterranean axis of disturbance, less apparent, but probably exerting greater dynamic forces than those which brought the granitic rocks to the surface through weak points of the superficial crust.

The mineral veins which have been detected traversing the neighboring strata, have, no doubt, a connection, and owe their origin to the causes brought into action during the production of these crystalline rocks and the metamorphism of the strata. The high mountainous regions of Izard, Searcey, Van Buren, Conway, Pope, Johnson, Newton, Madison, Franklin, Washington, Crawford, Sebastian, Perry, Yell, Scott, Polk, Sevier, Montgomery, Pike, and Hot Spring Counties, owe as certainly their elevation to the same cause, operating however through a vast period of time and slumbering, even at this day, under the Whetstone and Crystal Mountains of Hot Spring and Montgomery Counties, as will be hereafter explained.

There is another granitic axis which, though it only reaches the surface on a branch of Spavinaw Creek, beyond the northwest limits of the State, undoubtedly indicates the close proximity of a platform of the same material on which the lead-bearing rocks of the subcarboniferous group of the northwest counties of Arkansas, and the southwest counties of Missouri repose. A knowledge of the existence of igneous rocks beneath that region of subcarboniferous rocks, has a most important bearing in estimating the probable mineral character of that district of country, of which I have given some account in my previous volume.

In the first Report, a description was given of the geological position and mineral character of the vein of argentiferous galena, as it occurs on Kellogg Creek in Pulaski County. A vein, possessing very similar characters, has been observed during the progress of the work, in the last two seasons, at various points in Saline, Montgomery, and Pike Counties, but more especially in Sevier County, all having a constant bearing nearly in the same northeast and southwest course, and running almost parallel to the aforementioned range of the outcrop of the crystalline rocks. The facts ascertained render it probable that the metalliferous veins exposed on Kellogg Creek, in Pulaski County, may be traced from that locality in a southwest direction across the State to the Indian boundary line and beyond; and, perhaps, also, to a considerable distance to the northeast.

Evidence has also been collected, which renders it not improbable, that another metalliferous vein may exist on the south side of the granitic axis, extending even as far south as Wood Hill, in Ashley County.

The coal region of Sebastian, Scott, Yell, Perry, and the southern portions of Franklin and Johnson Counties, has been explored since the last Report, by which it has been ascertained that the thickest beds of coal, at present known in the State, crop out in Sebastian County, on the borders and in

the vicinity of the Jenny Lind Prairie, where they attain a thickness of four to five feet.

The coals seen in the southern parts of Franklin and Johnson Counties do not appear to exceed two feet in thickness. They generally lie low in the creek banks, skirting the edge of the prairies, covered by shaly clays impregnated with iron, and containing more or less iron-stone nodules, and rest upon stigmaria clays.

Along nearly the whole course of the Petit Jean Mountain Range, in Perry and Yell Counties, a seam of coal can be traced, usually from one foot to fifteen inches thick, occupying a position about one hundred feet above the base of the mountain.

In the higher ranges, for instance in the Magazine Mountain, coal of about the same thickness has been detected, upwards of five hundred feet above the levels of the farms in the plains below the mountain: whether this is the same, or a distinct bed of coal, has not been fully ascertained.

Since the first tracing of these seams of coal, as stated in the Introduction to the Report, M. Lesquereux has made a more special examination of the specific characters of the fossil flora of these coal-bearing strata, in order that all the palæontological evidence may be brought to bear on this subject, in aid of establishing the exact age of the coal beds.

You will see from a perusal of his Report, that the palæontological evidence of the geological position of these coals is in corroboration of the views formerly advanced,—that they are sub-conglomeritic; that is, that they lie below the horizon of No. 1 coal of the Kentucky sections, and are contemporaneous with the coals above the rapids of the Cumberland River, in Pulaski County, Kentucky, and that of Indian Creek, near the confines of Bath and Powell Counties in the same State.

In June of 1858, I made a partial examination of the waters of the Hot Springs, by boiling down one and a half gallons of the water taken from the Kitchen Spring, No. 19 of the chart accompanying this Report, and found the contents, approximately, reduced to one gallon, as follows:

	Grammes.
Organic matter combined with some moisture,	1.16
Silica with some sulphate of lime not dissolved by water,	1.40
Bicarbonate of lime,	2.40
" " magnesia,	0.50
Chloride of potassium,	0.04
" " sodium,	0.218
Oxide of iron and a little alumina,	0.133
Sulphate of lime dissolved by water,	0.350
Loss, Iodine? Bromine?	0.053
	6.254

In the winter of the same year, Dr. Elderhorst, then Chemical Assistant

to the Survey, was instructed to collect a sufficient number of gallons of the water to make an accurate quantitative analysis in my laboratory.

During January of 1859, he made an analysis of the solid contents in 1000 grammes of the water from the spring that gushes out near the base of the cliff of calcareous tufa behind the Pavilion, being the most northerly of the main group, mostly resorted to by invalids for drinking, and known generally as the "Arsenic Spring" (No. 25 of the Chart of the Hot Springs), under the supposition that it contained arsenic. This popular notion is not, however, confirmed by the chemical analysis. For 200 grammes of the calcareous deposit, in which it is more likely to be detected than in the quantity of water that could be conveniently subjected to analysis, failed to give any precipitate in the acid solution of that substance with sulphuretted hydrogen, which proved not only the absence of arsenic, but of lead, antimony, and in fact, all other metals precipitable in any acid solution by sulphuretted hydrogen, which includes indeed all the metals but Iron, Zinc, Cobalt, Nickel, Manganese, Uranium and the four rare acid-producing metals, Chromium, Tantalium, Niobium, and Pelopium; among this latter group of metals only a very small percentage of iron was found to be present, in the form of bicarbonate of the protoxide of iron, which is deposited, by long standing, as a dark-brown sediment, which, except at one of the Springs (No. 17 of the Chart), is so incorporated with the great mass of the carbonate of lime and siliceous earths, forming the cliffs and crusts of tufa, as to be undistinguishable to the eye.

Dr. William Elderhorst's analysis of 1000 grammes of the so-called "Arsenic Spring" (No. 25 of the Chart), is here inserted:

	Grammes.
Lime,	0.059024
Silicates,	0.045600
Sulphuric acid,	0.019400
Magnesia,	0.007629
Chlorine,	0.002275
Soda,	0.004650
Potash,	0.001560

In this analysis, the carbonic acid united with a portion of the lime and magnesia was not estimated.

The silicates, which were left undissolved on treating the residue obtained by evaporating the waters to dryness in a platina capsule, with hydrochloric acid, were fused with a mixture of carbonate of soda and potash, and qualitatively examined. They were found to contain Silica, Lime, Magnesia, Iron, and Manganese.

The quantity operated on was too small to determine the proportions by weight.

In the early part of August, 1860, I made a complete analysis of the spring on the hill, No. 1 of the Chart accompanying this Report.

The solid contents obtained by evaporating 1000 grammes (one litre) of this water to dryness, were separated into the portion soluble in water, and that soluble only in hydrochloric acid, and the acids and bases in each (except hydrochloric in the acid solution) separately determined.

In another portion of the same quantity of water evaporated to dryness, with a little hydrochloric acid, the total quantity of bases were estimated, and in a third portion the acids were determined.

The sediment found in the bottom of the bottle containing the water was also examined.

From these various analyses the following results were obtained.

The total quantity of matter, from 1000 grammes of this water, weighed 0.1518 grammes; of which 0.0018 was organic matter, which burnt off by ignition, emitting an odor like that from burning peat.* This organic principle is, probably, appocrinic acid, which was united with the oxide of iron; but the quantity obtained, from the amount of water operated on, was insufficient to demonstrate its properties sufficiently to enable me to decide positively on its identity with that organic acid.

After the organic matter was burnt off, 0.15 of saline matter remained. Of this, 0.0252 grammes were soluble in water, and 0.1268 insoluble in water.

The sediment at the bottom of the bottle weighed, when dry, 0.0300. This lost, by ignition, 0.0048, which was mostly organic matter, similar to that held in solution. The residue, 0.0252, gave up, to hydrochloric acid, 0.0092, which was mostly carbonate of lime, with a little oxide of iron, which had existed partly as carbonate of iron and iron combined with the organic principle; and a trace of carbonate of magnesia. There remained 0.016 insoluble in hydrochloric acid, which was at first a deep chocolate-brown color, and turned of a red ochre-color, after ignition. This proved to be mostly silica, with a little sulphate of lime, tinged with oxides of iron and manganese.

The various analyses gave in the sediment:

Organic matter (appocrinic acid?), ...	0.0048
Carbonates of lime; a little oxide of iron, which existed partly as carbonate of iron, and partly combined with the organic acid, and a trace of carbonate of magnesia, ...	0.0092
Silica, with a little sulphate of lime, tinged with oxides of iron and manganese, ...	0.0160
	0.0300

* Where the water is concentrated, or the solid extract treated with water, before this organic principle is burnt off, the solution has a yellow color imparted to it by the presence of this substance.

The part of the matter soluble in water after evaporation to dryness and ignition:

Magnesia,	0.0040
Soda,	0.0120
Potash,	0.0030
Chlorine,	0.0060
Sulphuric acid,	0.0002
	0.0252

The part insoluble in water, after evaporation to dryness, and before ignition:

Organic matter (appocrinic acid?) burnt off by ignition,	0.0018
Silica and silicates, insoluble in acids,	0.0600
Carbonate of lime,	0.0600
" " magnesia,	0.0040
Alumina and oxide of iron,	0.0010
	0.1268

Calculating the probable combinations of these acids and bases, as they are, in all probability, united in the water, we have:

Appocrinate? of protoxide of iron,	0.025
Silica and insoluble silicates,	0.060
Bicarbonate of lime,	0.086
" " magnesia,	0.006
Alumina and oxide of iron,	0.001
Carbonate of soda,	0.0170
" " potash,	0.0040
Sulphate of magnesia,	0.0002
Chloride of magnesia,	0.0026
Sulphate of lime,	0.000015

There is still an excess of magnesia remaining, which probably exists as iodide and bromide of magnesia; for, though Dr. Elderhorst, operating on 1000 grammes, was not able to detect any Iodine or Bromine; yet, when I extracted the solid residue from 2000 grammes with alcohol, evaporated this to dryness, at a low temperature, and tested it with protochloride of Palladium, the watery solution was slightly tinged yellowish-brown, indicative of a trace of iodine; and, if larger quantities of the water were operated on, the iodine and bromine could, in all probability, be distinctly brought out.

I have been repeatedly asked to what I attributed the medical virtues of these waters. I reply, *mainly to their high temperatures.* Here, at the Hot Springs of Arkansas, there is the most abundant supply of water at a

scalding temperature; several of the springs ranging at the fountain-head as high as 148° of Fahrenheit's thermometer, the waters of which, after being conducted in open troughs down the hillside to the reservoirs above the bath-houses, and standing some time, are just as hot as the skin can bear, and the waste water conducted under the adjoining vapor bath-houses, sends up a steam, through the latticed floor, of a temperature so hot that few can endure it. If, then, the Warm Springs of Virginia, which have a temperature of only 96° to 98°, exercise, as experience has proved, a most potent effect in the cure of many diseases, "*mainly by their temperature*," how much more positive must be the effect of waters of so much higher temperatures; especially when a stream of it, *in diameter as large as a man's arm*, can be directed, at pleasure, with great force, on any organ.

In many forms of chronic diseases especially, its effects are truly astonishing. The copious diaphoresis which the hot-bath establishes, opens in itself, a main channel for the expulsion of principles injurious to health, made manifest by its peculiar odor; a similar effect, in a diminished degree, is also effected by drinking the hot water,—a common, indeed almost universal practice, among invalids at the Hot Springs.

The impression produced by the hot douche, as above described, is indeed powerful, arousing into action sluggish and torpid secretions; the languid circulation is thus purified of morbific matters, and thereby renewed vigor and healthful action are given both to the absorbents, lymphatics, and to the excretory apparatus,—a combined effect, which no medicine is capable of accomplishing.

Silica and carbonate of lime, the most abundant mineral constituents of the Hot Springs, can have comparatively little specific action on the animal functions. The carbonates of alkalies present, proved by the distinct alkaline reaction of the watery solution of the solid contents evaporated to dryness, cannot be without their therapeutic effects, in common, however, with a great many of the well and spring waters of Middle and Southern Arkansas, which also contain some alkaline carbonates.

The large quantity of free carbonic acid which the water contains, and which rises in volumes through the water at the fountain of many of the springs, has undoubtedly an exhilarating effect on the system; and it is no doubt from the water of the Hot Springs coming to the surface charged with this gas, that invalids are enabled to drink it freely at a temperature at which ordinary tepid water, from which all the gas has been expelled by ebullition, would act as an emetic.

The small quantities of chlorides and sulphates of magnesia may have a slight medicinal effect; but there are not more of these salts present than are to be found in many spring and well waters employed for domestic purposes.

Various have been the speculations with regard to the cause of the high

temperatures of these waters, and my opinion has been repeatedly asked on this subject.

I cannot, for several reasons, subscribe to the views advanced by some, that the elevation of temperature is caused by the water coming in contact with caustic lime in the interior of the earth. Lime has so great an affinity for carbonic acid that it cannot remain, for any great time, in an uncombined caustic condition; and, therefore, is seldom found in that state either on the surface or in the bowels of the earth. And if it did, it would long since have been reduced to the state of hydrate, if not to the state of carbonate, by constant contact with this copious flow of water charged with carbonic acid; when it could no longer give off heat by the chemical action produced during its combination with water.

Much less can I give assent to the extraordinary idea, that the high temperature of these waters is due to latent heat, given off from the water in the act of depositing the tufa that now coats the hillside from which the springs issue, and which was originally held in solution; since we have no instance of any appreciable heat being given off by simple precipitation or settling out of the carbonates of lime, as it loses the carbonic acid which held it in solution: besides, this is so slow a process that if any heat were given off, it would be so little at a time as to be insensible to the feelings.

On the contrary, I attribute the cause to the *internal heat of the earth.* I do not mean to say that the waters come in actual contact with fire, but rather that the waters are completely permeated with highly-heated vapors and gases which emanate from sources deeper-seated than the water itself. The whole geological structure of the country, and that of the Hot Spring Ridge in particular, from which the water issues, justifies this assumption.

This ridge or mountain, as it is usually called (though it is only two hundred and fifty feet above the Hot Spring Valley), is made up of the most beautiful variety of Novaculite ("Ouachita oilstone or Arkansas whetstone"); equal in whiteness, closeness of texture, and subdued waxy lustre, to the most compact forms and white varieties of Carrara marble; and, though of an entirely different composition, it resembles this in external physical appearance so closely, that, looking at specimens of these two rocks together, it is difficult to distinguish them apart. Indeed, the finest quality of the Razor honestone variety of this formation is even superior in purity of whiteness to the celebrated Carrara marble. Except in being less translucent, it approaches in lustre and fineness of structure to Chalcedony. It is, in fact, the most beautiful variety of Novaculite that can be imagined, when taken dry and fresh out of the quarries, about the middle of the east slope of the Hot Spring Ridge.

Yet this snowy white chalcedonic novaculite belongs, undoubtedly, to the age of the millstone grit, and was once a simple ordinary sandstone.

From the state of an ordinary sand-rock, it has been altered or metamorphosed into this exquisitely fine material, not as I conceive, by contact with fire or igneous rocks, but by the permeation of heated alkaline siliceous waters; perhaps somewhat hotter than the springs issuing at this moment from the Ridge, and somewhat more strongly impregnated with silica, potash, and soda. By the incessant and long-continued permeation of the sand-rock with such waters, the particles of said rock have been gradually changed from grains of quartzose sand to impalpable silica, and the greater part of the oxide of iron, manganese, and other impurities, carried out in solution from the pores of the rock, leaving nearly chemically pure silica behind.

The chemical analysis of this novaculite rock confirms this opinion, since it is found to be composed in 100 parts of 98 pure silica, as shown by the subjoined analysis:

Silica,	98.00
Alumina tinged with oxide of iron,	00.80
Potash,	00.60
Soda,	00.50
Traces of lime, magnesia, hydrofluoric acid, and moisture,	00.10
	100.00

Standing at the north extremity of the Hot Spring Ridge, at the turn of the road below Col. Whittington's house, and looking at the exposed and bare walls of this novaculite rock for the first time, even a geologist, seeing its fissured condition, and the rock standing, apparently, almost on edge, would, at first, suppose that it had been shivered by internal and tremendous convulsions; but the more I examined this formation, the more I became convinced, that, though tilted somewhat out of its original horizontal position, the numerous conspicuous, nearly vertical joints in it, are fissures of cleavage, and not seams of stratification, and that, during the metamorphosis of structure of which I have just spoken, the original stratigraphical partings have almost disappeared, or at least, become confounded with the fine and manifold lines of cleavage, concomitant with the altered structure of the rock. This formation is, indeed, one of the most remarkable and interesting for the study of this kind of metamorphism, that I have ever had the good fortune to investigate.

Though we have, all along the southern flank of Hot Spring Ridge, upwards of forty hot springs, issuing at temperatures varying from 100° to 148° of Fahrenheit's thermometer, flowing down the slope seen on the left of the view of the Hot Springs, forming the frontispiece to this Report, we have, as yet, discovered no outcrop of real igneous or crystalline rocks nearer than Tiga Creek, on the borders of the Magnet Cove, a distance of ten miles, in a direct line, from the Hot Springs.

When we reflect on the boundless and never-ceasing flow of thermal waters that must have bathed the sides of Hot Spring Ridge for countless ages, perhaps commencing even as far back as the termination of the carboniferous era, at least for a sufficient length of time to effect the metamorphism of this great thickness of millstone grit, we must become impressed with the vast duration and long-continued action of geological phenomena compared with our historic period; and however inexplicable such wonderful phenomena and changes may at first appear, yet, when the chemical principles become properly understood, disclosed by enlightened and accurate chemical analyses, these obscure geological transformations can be satisfactorily and clearly explained, aided by the evidence of the persistency of such chemical agencies through a long lapse of time.

In the adjoining county of Montgomery, in the Crystal Mountains, some twenty miles distant from the Hot Springs, we behold a modification of similar, though far less intense, chemical action, which has produced equally interesting, but less widely-diffused results; the same millstone grit formation, rising into even more elevated ridges than at the Hot Springs, and composed, even at this day, of massive sandstone, retaining still all the physical characters of a sedimentary deposit. These sandstones have, however, been very slowly and partially permeated by alkaline silicious waters, particularly along their joints and lines of stratification; in the insterstices of which the most brilliant, transparent, and limpid quartz has crystallized in all the regularity, beauty, and variety of its own peculiar geometrical forms, reflecting from their glassy facets a dazzling degree of light, second in brilliancy only to that of the diamond. Here the passage or transpiration of the pure nascent silex has been effected without changing, to any considerable degree, the structure of the sandstone matrix, which may be found, in all its rough and gritty contrast, attached to the base of a group of perfectly limpid crystals.

There is, at present, no region known on this continent which presents such extensive mines of rock-crystal as the gorges of the mountainous ridges of Montgomery County. Almost every fissure of this vast sandstone formation, for a distance of one to two miles in length, and from three-quarters to one mile in width, is lined with these brilliants, which, exposed in bursting open the crevices of the rock, glitter and flash in the sun's rays like a diadem. Any one provided with the proper tools can collect, in a few hours, more than he can carry away.

Here, as in the Alps, we have the "Crystal-hunter" exploring the recesses of this great crystal mountain, and carrying his glittering "*points*"* to the Hot Springs and elsewhere, exposing them for sale on the doorsteps of the hotels and in the shop windows, as attractions for strangers, to serve

* A term used by the Crystal-hunters synonymously with crystal.

by their purchase as remembrances of the buyer's visit to the crystal regions of Arkansas. And truly, by a judicious selection, the lover of the mineral kingdom may here possess himself of gems of superior water, that may vie in beauty and brilliancy with those of the Alps, Dauphiné, Piedmont, and Carrara, in Europe; and Ulster, Herkimer, Diamond Island, and Diamond Point, in the United States. With proper tools, slabs might be rent off from the face of the sandstone rock far more than a man could lift; in fact, even a cart-load, studded over with limpid crystals, of all sizes, from the fraction of an inch to five or six inches in length.

Here, in the Crystal Mountain, more remote from the centre of igneous action, by slow, undisturbed, and long-continued transudation, pure silicious matter has segregated its atoms into cavities, joints, and fissures, assuming, at the same time, the peculiar, regular, mathematical form, which this chemical substance is prone to take, when left to undisturbed disposition of its particles,—a beautiful and gigantic illustration of that wonderful law in mineralogy by which every mineral substance, in a state of purity and rest, arranges its particles in definite and regular geometrical solids, the facets of which often possess a lustre equal to the highest polish, and are inclined at angles peculiar to each particular species.

It is evident, from the analysis of the deposit made by the water of the Hot Springs, that most of the silica it holds in solution is not deposited as rapidly as the carbonate of lime; for, though the amount of silica and insoluble silicates held in solution in the water, falls but little short of the carbonate of lime, yet in the tufaceous deposit only a fraction of one per cent of silica* is present; hence, much of this substance must be carried away by Hot Spring Creek, into which all the springs empty, to be deposited along its course by the evaporation of the waters of this stream; and it may be that, in this operation, particles of the Whetstone Mountain are, by slow degrees, corroded and removed from their ancient bed, and precipitated elsewhere.

One thing is evident, silica forms a very frequent constituent of the spring, creek, and well-waters of Arkansas. I detected it, in considerable quantities, oozing in rivulets, down the sides of the mountain, and in the creek-waters flowing through the main valley.

From sixteen fluid ounces of the water of the Crystal branch of the Walnut Fork of Ouachita River, where it flows in the heart of the region of rock crystal, I obtained by evaporation to dryness,	0.100	grammes.
Which lost by ignition (water and organic matters),	0.006	"
Leaving earthy and saline matters,	0.094	"

* This is shown by the subjoined analysis of the calcareous tufa deposited by the Hot Springs.

From this I obtained:

Carbonate of lime,	0.0285	grammes.
" " magnesia,	0.0080	"
Silica,	0.0095	"
Sulphate of lime,	0.0070	"
Alumina and oxide of iron,	0.0020	"
Carbonate of potash,	0.0090	"
Sulphates and chlorides of magnesia and soda, and loss,	0.0300	"
	0.0940	"

The quantity operated upon did not admit of estimating, with great exactitude, quantities of the saline matters, existing in smaller proportions, as sulphates and chlorides of magnesia and soda, &c.; but the above approximate result is sufficient to show the notable quantity of silica and carbonate of potash present; the latter, the solvent of the silica, which is in a favorable condition to form crystals of quartz.

This analysis gives confirmation to an opinion which I find prevalent among many of the crystal-hunters,—that crystals of quartz are in process of formation, even at the present day, in these singular districts of Arkansas; and I have little doubt but this peculiarity of its waters, must, more or less, stamp its influence on the constitution of its inhabitants.

Though the chemical properties of silica are rather of a neutral character, it is, nevertheless, considered to have its effects upon the animal organs and secretions, promoting, in certain constitutions, a tendency to deep-seated abscesses with deep-seated pus, fungus cancers, epilepsy, and inflammations of the parotid gland; and in scrofulous persons, it may increase the tendency to pulmonary consumption.

I am not prepared to say that, in the combination and proportions in which it exists in the waters of these countries, it will produce such effects; I only throw out these remarks, as hints for the attention and observation of practising physicians and others.

Carbonates of alkalies, when present in considerable quantities, as in the "Soda and Beer Springs" on the route to California, have a corrosive effect on the mucous membrane of the stomach, besides neutralizing the gastric juice, and thus arresting all digestion and assimilation of food; and it is from these combined effects that so many cattle have been lost by drinking at these springs on the plains. In the much smaller proportion in which they exist in the waters in question, no such active injurious effect is produced. Indeed, the carbonates of potash and soda are considered very serviceable in correcting the lithic acid diathesis which is apt to result in calculus, containing this acid. In such cases, there seems to be, usually, an acid condition of the alimentary canal, which these alkaline carbonates correct. They also often give relief in affections of the kidneys.

But in other constitutions, the constant use of water containing carbonates of the alkalies, in any notable quantity, might impair the digestive function. It is for these and many other reasons, too numerous to state in this Report, that I have generally recommended to the inhabitants of those regions, where I have found the spring or well waters strongly impregnated with these and other mineral substances, possessing medicinal properties, to provide themselves with large cisterns, and collect pure rain water for ordinary domestic purposes. Where the constituents in well and spring waters, are, as most frequently, only carbonate of lime and common salt, there is no objection to their use, as these substances are essential requisites in the organs and secretions of the animal economy. Indeed, the latter substance is so important to the health, that in all inland countries, removed from the influence of the sea air, there is a natural craving among animals for salt, so irresistible, that they will overcome every obstacle and expose themselves to all kinds of dangers, for the sake of obtaining it. In excess, however, even this wholesome condiment is the cause, in part at least, of that horrid disease, scurvy, to which sailors, and all persons fed exclusively and constantly on salt provisions, and exposed to a damp atmosphere, are liable. It may be laid down as a general rule, that however advantageous mineral waters may be for temporary use, and in particular cases of disease, that they are not applicable or wholesome for *constant or domestic use.* Even if the constituents are only carbonate of lime and common salt, when these exist in proportions much exceeding $\frac{18}{1000}$ of carbonate of lime and $\frac{6}{1000}$ of common salt, it is better to use, habitually, pure rain water.

When there is common salt in waters, there are very apt to be, also, iodides and bromides, either of potash or magnesia; but the quantity is usually so small that they can only be detected by boiling down large quantities of the water. Iodine is considered essential to the health of man,* inasmuch as it seems that where it is nearly or entirely absent in the waters of a country, as in many parts of Switzerland, Savoy, and the Apennines (the springs taking rise or running over granite and mica slate), that the inhabitants become thereby subject to chronic enlargements of the thyroid gland, called goitre, unless iodine is supplied in some articles of diet. In excess, however, this substance reduces the

* Recently, the researches of Dr. Boinet have shown that there are regions near the sea-coast, where iodine is abundantly diffused through the air, in which certain diseases, such as cretinism, enlarged glands, worms, &c., are rarely seen; and, therefore, he recommends, where these diseases prevail, especially in children, to cook, with their food, such plants as contain iodine, as sea-weeds and cruciferous plants; or else use the water of iodized springs, or introduce iodine, in very small quantities, into articles of diet, cakes, syrups. After ten years' experience, Dr. Boinet asserts, that if this treatment is persevered in with children of decided scrofulous habits, that, not only ordinary cases of scrofula can be cured by it, but ulcerous habits, diseases of the skin, ophthalmia, caries of the bones, &c.

whole glandular system, and in persons of plethoric habit it is apt to produce local congestions.

A qualitative examination was made by Dr. William Elderhorst of the "Fairchild's Chalybeate Spring," about three miles from the Hot Springs. He found in it:

Sulphates,	large quantity.
Chlorides,	" "
Lime,	" "
Iron,	" "
Magnesia, Soda, Manganese,	Strong reaction.

This spring is now owned by Allen and Vaughan.

On the 9th of July, 1859, after the property had been purchased by these gentlemen, I visited the spring, and tested it, qualitatively, at the fountain-head. Its temperature was 70° Fahrenheit.

I found it to have an alkaline reaction, which may be due, in part, to the presence of carbonates of the alkaline earths, lime and magnesia.

Its principal ingredients were ascertained to be:

Bicarbonate of the protoxide of iron.
" " lime.
" " magnesia.
Sulphate of magnesia.
" " soda.
A little chloride of sodium, and perhaps a little carbonate of soda.

This water has a slight deoxidizing effect; especially that spring known more particularly, as the "Sulphur Spring," though there is little or no sulphuretted hydrogen present; at least, not enough to perceptibly darken lead-salts. This spring has more chlorides in it than the main spring.

The spring to the southwest of the main spring, which supplies the ladies' bath, has a temperature of 67°.

These springs afford a most abundant supply of water; some one hundred and fifty gallons per minute; in fact, there is enough of waste water to drive a small mill, which supplies meal to the establishment.

The source lies in the dark slates underlying the whetstone formation, on the east side of the main Hot Spring Ridge. Carbonic acid rises incessantly with the issue of the water from the fissures of the slates, in a rapid succession of air-bubbles, through the transparent pool, which adds greatly to the exhilarating effects.

This water is, therefore, a saline chalybeate, having medical properties, eminently tonic, slightly aperient, and well adapted for the use of patients recovering from intermittent fever, if there be no inflammation or inflammatory action to counterindicate its use.

The distance of this spring from the Hot Springs, being only a pleasant ride, it is a favorite resort for those who desire a change of scene, and when the system requires toning up; or, in other words, when an increase of the red globules of the blood is necessary, it will be found very efficacious in effecting a final cure.

The nearest crystalline rocks to the Hot Springs which have, as yet, come under my observation, are on Tiga Creek, on the confines of the Magnet Cove. This cove, though the area is not very extensive, nor yet very elevated, seems to be the centre of the igneous action of Hot Spring County.

The igneous rocks occupy the depressed portion only of the Cove, and the lower subordinate ridges. The higher ridges, by which the Cove is bounded on the north, are composed, in great part, of the novaculite rock. A continuation of this ridge extends, on the west side of the Cove, from Section 8, through the southern part of Section 7, T. 3, S. R. 17 W.; and thence, through the east portion of Section 13, into Section 24, T. 3, S. R. 18 W. A portion of this ridge seems to be composed of a greenish, coarse-textured rock, resembling clinkstone, known under the name of the "*Mountain Rock;*" but I believe, when this region is surveyed in detail, that the great body of the rock in this ridge will be found to be some modification of novaculite, or bluish-gray quartzite. South of the Cove, at Rockport, a great wall of true novaculite runs into the River Ouachita, on the east side, with an outlier on the opposite side, forming as complete natural abutments for a bridge as could possibly be desired.

Were it not for the fissured condition of the rock, a very fine quality of honestone could be procured at this locality.

This conspicuous wall of Ouachita honestone forms quite a picturesque object. Sketch, Pl. A, is a view taken from the west side of the river, opposite Rockport. It is probable that this is the locality whence the name of "*Ouachita oilstone*" was originally derived.

There is, probably, no portion of Arkansas that affords a greater variety of minerals than Magnet Cove. Here, in a circumscribed area of less than two miles, we found:

Black garnets, crystallized.		Iron pyrites, crystallized and amorphous.	
Green, yellow, and black mica, crystallized.		Strontianite?	"
Schorlamite,	"	Arkansite,	"
Quartz,	"	Elæolite,	crystallized.
Lydianstone,		Actinolite,	"
Agate,		Epidote,	"
Pyroxine,	crystallized.	Arragonite,	"
Hornblende,	"	Talc.	

Magnetic iron ore, and, no doubt, many other minerals exist, not yet enumerated.

The most prevalent rocks are:

Novaculite.	Milky quartz.	Hornblende rock.
Quartzite.	Chert.	" porphyry.
Sienite.	Burrstone.	" slate.
Granite.	Kieselschiefer.	Schorlamite rock.

The magnetic iron ore occurs in large bodies, occupying a surface area, a little to the centre of the Cove, of four to five acres, over which the whole ground is strewed exclusively with the finest specimens of this ore, much of which has polarity. The soil in this part of the Cove is of a dark chocolate-brown, from the large amount of oxide of iron present.

Titanic acid is abundantly disseminated amongst the minerals of the Magnet Cove. It enters not only into the composition of the magnetic iron ore, but occurs, crystallized, in its purest variety, containing only a mere trace of silica. The specimens collected and analyzed appear, indeed, to be the purest form of Brookite or Arkansite on record, as the quantity of silica separated was almost inappreciable on the most delicate chemical balance; and neither oxide of iron or alumina could be detected in appreciable quantities.

In some parts of Magnet Cove, the magnetic needle is strongly affected, not only in its vertical dip, but in its horizontal deflection.

The Fourche Cove furnishes a very fine specimen of Kaolin, or porcelain clay, derived from the decomposition of felspar. This material seems to exist in considerable quantities at the locality where I had an opportunity of inspecting it; and, from the felspathic character of much of the rock of this cove, I have little doubt that it might be found in many new localities where it has not yet been discovered.

Noble quarries of granite could be opened, both on the north slope of the granite range in the Fourche Cove, and in the cedar glades on the waters of Hurricane and Lost Creek. At this latter locality, some very good millstones have been got out, which, though not equal to the burr-millstone, make nevertheless excellent stones for grinding corn.

All that is wanted, in order to establish an extensive business in supplying, not only the State of Arkansas, but the whole South and West, with the most substantial of building materials, is cheap and easy communication between the quarries and Little Rock, where the granite blocks could either be shipped on the Arkansas River, or transported on the lines of railroad which, no doubt, must soon concentrate in that place.

The quarries on the north edge of the Fourche Cove are only between two and three miles, in a direct line, from Little Rock, and close to one of the proposed routes of the Cairo and Fulton Railroad. One set of the cleavage joints of the granite of this locality conforms to the slope of the hillside, where the rock is best exposed; so that, comparatively, a small power is required to slide even huge dimension stones from their native

bed, down the natural inclined plane, to platforms placed beneath to receive them.

Felspar enters largely into the composition of the Fourche granite; it is of a white color, and has the cleavage of an albite or soda felspar; but, from a qualitative examination of this felspar, it seems to contain fully as much, if not more, potash than soda.

On Section 21, T. 8, S. R. 25 W., two miles south of Murfreesborough, in Pike County, there is also a circumscribed area of igneous rocks, consisting mostly of porphyritic greenstones, which occupy a width, from north to south, of one hundred and fifty to two hundred yards. A hill, a few hundred yards from this outburst, is composed of a kind of trachytic rock, and a decomposing rock of similar felspathic origin, which is now a kind of wacke.

This igneous outburst has pierced the sandstone and slate of the millstone grit period, and, in places, heaved the sandstone up at angles of 46° to 48°. A local conglomerate has been here produced, no doubt, by the attrition of the sandstone surfaces, during the movements of the beds, one upon another, during the action of the subterranean forces, which brought these hypogene rocks to the surface. This locality reminded me forcibly of the small volcanic tract of the Adige, in the Department of the Herault, in France, of which I have a fine suite of specimens in my collection.

Two instances have been observed of overlying crystalline rocks. One on the southwest bank of the Ouachita River, a short distance above the Gap Mill, and about a mile from the edge of the Magnet Cove. Here, a hard, tough, hornblendic rock, with large flakes, and crystals of jet black mica, is seen reposing conformably on comparatively soft layers of slate, inclined at an angle of 10° to 11°, dipping into the Ouachita River, obliquely across its channel. No vestige of this rock can be seen to the southwest, beyond a small ravine which comes down to the river, hardly one hundred yards from where it disappears below the water on the opposite course. From this, I infer, that that ravine marks the place where this porphyritic hornblende rock has come up from beneath; but the vegetation prevented me from tracing this rock, in its downward pitch, at this ravine; and, indeed, it is probable that the overlying tabular mass above conceals from view the source from which it issued.

Though the actual surface-exposure of crystalline and igneous rocks in Arkansas is but limited, nevertheless the metamorphism and disturbance of the strata are most conspicuous and extensive.

In the Cossatot Range of Polk County, the strata consist of metamorphosed sandstones and shales, which may be observed for miles standing almost on edge, even on the summit of one of its principal peaks, the Hannah Mountain, which was ascertained, by the aneroid barometer, to be one thousand feet above the Cossatot River. The beds of indurated sandstone, quartzite, and novaculite, may be observed, like artificial walls,

running up the flanks of the mountain, even to its summit, inclined at angles of 70°, preserving a perfect parallelism, the depressed interval between the walls of sandstone being filled with slates, more or less indurated and crumbling.

For miles, too, along the road leading through the Cossatot valley, similar strata may be seen, almost on edge. The same phenomena may be observed on the Fourche La Fave Range, where the road south of Waldron, in Scott county, passes over tilted strata of sandstones and shales; and, though there are reversals in the dip evident in places, yet the road passes for miles over the edges of such strata without any reversal apparent on the surface, giving strong evidence of the immense thickness of the beds. Yet they all seem to be of the age of the millstone grit; or, at least, not lower than the base of the subcarboniferous group, because they overlie rocks of Devonian date; and have, intercalated, towards their base, limestone and black flint, which, though often brecciated and metamorphosed into a black-veined marble, are undoubtedly of the same age as the black limestone and flint of Wiley's Cove and Shields's Bluff, which belong to the date of the Archimedes and Pentremital beds of the subcarboniferous group; and all the evidence, as yet obtained, goes to show that the highest and newest of this great series of sandstones, slates, and shales, with subordinate limestone, are of greater antiquity than the true coal-measures, and lie at their base.

At present we have not sufficiently accurate measurements to give anything like the exact thickness of this group,—the great and leading formation of Arkansas; but my present belief is, that when it comes to be measured and surveyed in detail, it will be found to rival, in combined thickness, that of the great sandstone formation which girdles the eastern and western shores of Scotland, forming the southern flanks of the Grampians. Both this range of Scottish hills and the Arkansas rocks, abovenamed, conceal an internal nucleus of granite, and perhaps porphyry, which they envelop and on which they repose, with the intervention, probably, of mica slate. Now, if that so-called old red sandstone of the Grampians represents, as in Caithness (another district of Scotland), three entire formations,—the old red system, the carboniferous, and the new red sandstone,—then the Arkansas formation in question is contemporaneous with a part only of the middle of these divisions.

But if those transatlantic beds belong exclusively to the Devonian period, then it is extremely doubtful whether any of the slates and sandstones in question in Arkansas belong to the same age. As this classification, however, depends altogether on the specific character of the imbedded organic remains, which, as a general rule, are remarkably scarce in Arkansas, and as yet only imperfectly known, further investigation is necessary to throw light on the subject. Those fossils which have been found locally

in the limestone are decidedly such as occur in the division of the subcarboniferous limestone; *i. e.* in the Productal, Archimedes, and Pentremite-beds; and even the slates and shales, subordinate to these limestones, as far down as we have been able to see them, afford no evidence as yet of being any older, if as old, as the shales and sandstones of the knobs of Kentucky and Indiana.

In less elevated situations than the Hannah Peak, two most remarkable and conspicuous instances have come under my observation of an absolutely vertical position of contemporaneous sandstones and slates; illustrations of which are given in the woodcuts, heading the sections on Pulaski and Polk counties.

One of these occurs at a ford on Boardcamp creek, in Polk county, where a vertical wall, ninety feet high, and four to five feet wide, of metamorphosed sandstone, stands out from the incoherent, flanking slates in the boldest relief, as shown in the sketch, and overhanging the waters of the stream, in the bed of which it is lost to view in its descending course.

The other example is on the Arkansas River, in Pulaski county, within view of the Pinnacle, and about eleven miles from Little Rock. Here, two perfectly parallel vertical walls of sandstone, twenty feet apart, jut out from the disintegrated soft slates, in prominent conformity, descending steplike, fifty-one feet from the top of the bank, where they first show themselves, to the edge of the lowest water-mark of the Arkansas River, and can be seen running their course beneath the stream. These form a conspicuous landmark to boatmen and travellers on the Arkansas River, and are known under the name of the "Natural Steps." The sketch referred to gives a view of this remarkable vertical section of sandstones and slates, as it appears from the water's edge, at the foot of these natural steps.

When I speak of metamorphism of strata, let me not be misunderstood. I have no idea that the extensive induration and alteration of the rocks in Arkansas, from their original condition after deposition and simple consolidation, have been effected by actual contact, or even close proximity to incandescent matter. On the contrary, I am of opinion, that the modification of texture and structure has been produced principally by permeation of highly-heated gases, vapors, and alkaline silicious waters; and that the various degrees of change observable are from a difference in intensity and phase of similar action. That this is the true explanation of the phenomena is proved by the fact that the *pervious* beds of sandstone are much more altered than the *impervious* shales. These are, for the most part, only locally indurated into hard slates, and are commonly liable to undergo by exposure rapid disintegration. Although not much indurated, they are rent asunder, and the intervals filled mostly with milky quartz,—forming, in some instances, veins of great extent, which sometimes ramify, like a

network, through the slate. Only in a very few instances are the silicious varieties hardened into durable roofing slates; while the sandstones, over large areas in many counties, are not only indurated, but often completely changed in structure and texture, in the manner already explained, passing into quartzite, chalcedonic chert, flint, and novaculite.

South of the base line, which is near the parallel of 34° 30′, there is less limestone intercalated with the slates, while the latter are more intersected by quartz veins, which especially prevail in Hot Spring, Saline, Montgomery, and Polk counties. The direction of these veins generally describes an acute angle with the strike line.

The most frequent strike line is west 20° south, and east 20° north; in some instances, it deviates more to the south and north of a west-southwest and east-northeast course.

The silica has most likely been brought to the surface through the solvent powers of the alkalies, potash and soda, derived from the granitic nucleus, which is eminently felspathic, where it appears on the surface.

On some of the geological charts of the United States, the Cretaceous formation has been extended into the interior of Arkansas, as high as latitude 35° 40′; that is, up the valley of White River, to near Jacksonport. On Rogers's Geological Map of the United States, published as one of the series of Johnston's Physical Atlas, the cretaceous system has been represented as crossing from the New Madrid region of Missouri, into Arkansas, about the "Sunk Land" district of the St. Francis country; that is, about latitude 36° 30′, and extending thence, with a southerly curve, to near the region of the Petit Jean Mountain, in Perry county; that is, about latitude 35° 20′. On Marcou's "Charte Géologique des Etats-Unis de l'Amérique du Nord," the cretaceous system is represented as extending as high as Pulaski county, in the vicinity of Little Rock; *i. e.*, to about latitude 35° 42′.

I have not been able to detect any symptoms of Cretaceous strata, even in deep wells, any further north in Arkansas than Clark County, about two and a quarter miles northwest of Archidelphia; *i. e.*, near the line between Townships 7 and 8 south, in about latitude 34° 6′.

At the fine section exposed on the Arkansas River, at "White Bluffs," *i. e.*, about latitude 34° 27′, beds of quaternary date occupy the higher part of the bluff; while the lower fifty or sixty feet, extending down to low water mark of the Arkansas, is most decidedly tertiary shell-marl of Eocene date, affording the following species: *Cardita densata, Fusus magnocostatus, F. Fittonii, Corbula Alabamensis, Monoceros vetustus*, and others undetermined.

Even at a point on the river bank, where a considerable disturbance and tilting of the strata are conspicuous, nothing lower in the geological series can be seen than Eocene tertiary. The marine shell-marl exposed

near Madison, in St. Francis county, Arkansas, near high water mark of the Mississippi, about latitude 35°, is altogether Eocene tertiary.

This section at the White Bluffs, and that examined by Assistant Geologist E. T. Cox, present the best exposition of the tertiary formation of Arkansas as yet observed.

Both these localities can furnish an abundant supply of shell-marl, having fertilizing properties, the analysis of which will be given under the head of Jefferson and St. Francis counties. Tertiary limestone has also been observed at various localities in Pulaski and Pike counties, some of which is fit for burning to lime.

These tertiary beds, undoubtedly, rest on cretaceous deposits beneath the drainage of the country. But if the colored belts on geological maps are intended to represent the surface area over which the strata, indicated by that coloring, are visible to the eye above the drainage of the country (which is the information that, I understand, a geological map conveys), then, not one of the maps has represented the exposed cretaceous area with even an approximation towards the truth.

Hempstead county, and the southern part of Clarke and Pike counties, may be considered the principal seat of the fairly exposed rocks of the cretaceous system of Arkansas.

The exact boundary can only be determined by a detailed survey, connecting the most northerly points in Clark, Pike, and Sevier counties, where the cretaceous formation has been observed during the survey, viz., on Section 8, Township 7 south, Range 19 west, in Clark county, in the vicinity of Murfreesborough, in Pike county, and the glady prairies near Ultima Thule. The north boundary line of the cretaceous formation of Arkansas deviates but little from an east and west line; rather a little south of west and north of east, but only about 10° to 20°. Thus, the exact limits can only be approximately defined.

Large bodies of iron-ore, belonging to the tertiary era, exist in Pulaski County, worthy the attention of the iron-master, as will be more particularly noticed under the head of Pulaski county; and analyses given of some of the principal varieties.

Iron-ores of the same age are, also, extensively distributed in the northern part of Bradley county; and tertiary shell-marls are frequently struck in the wells in this county, and sometimes partially exposed in the cuts of the creeks.

It is probable that most of the thick beds of lignite in Pulaski, Jefferson, Ouachita, and Calhoun counties, belong to the same age; but there are other beds of lignite, of less extent, which, I believe, will prove to be of quaternary date. These tertiary and quaternary lignites, according to the distillation-analyses conducted in my laboratory, yield from thirty to

forty-five gallons of crude oil to the ton of two thousand pounds. The oil is of superior quality generally.

In the immediate vicinity of the beds, when they are three to four feet thick, and are of good quality, not too much mixed with earthy matter, this combustible might be employed as a fuel, especially in situations remote from the markets of good bituminous or anthracite coal; and where there is a scarcity of timber. But this lignite can never, commercially, come in competition with such coal, for several reasons: first, it contains too much water, which, in passing from the state of water into steam, during combustion, absorbs too much heat; secondly, it contains too small a proportion of fixed carbon to make a lasting fire, and, in many instances, contains too much ash; finally,—and this is the most serious objection of all—when exposed to the weather, it soon crumbles away into small fragments, and, at length, passes into a kind of coal-dust; this is the case even with the most solid varieties, such as occur on the Ouachita and Saline rivers. They are, moreover, very liable to spontaneous combustion, when thrown into large heaps, in the open air.

If these lignites can be made profitable to the owners of tracts of land, where they occur in sufficient quantities, it will be for the manufacture of oil. The coal-oil business has now become of commercial importance. Though it is now only two or three years since there were but two coal-oil works in the United States, manufactures of this kind have been springing up with astonishing rapidity, wherever the country has afforded a coal that gave promise of a productive yield in oil.

According to a table which appeared recently in the Scientific American, the coal-oil manufactured daily, in the United States, ending the 31st December, 1859, amounted in various establishments, in different States, as follows:

Names or Place of Works.		Gallons.
Downer, Boston,	Mass.	1,500
Glendon, "	"	1,000
East Cambridge,	"	800
Page & Co.,	"	600
Suffolk,	"	300
Portland,	Maine,	500
New Bedford,	"	300
Hartford,	Conn.	200
Kerosene,	N. Y.	2,500
Columbia,	"	800
Carbon,	"	300
N. Y. C. Co.,	"	400
Empire State,	"	200
Several others,	"	500
Philadelphia,	Penna.	500
Pittsburg (four firms),	"	2,000

Names or Place of Works.		Gallons.
Great Western,	Ohio,	500
Newark region,	"	2,500
Wheeling,	Va.	200
K. C. C. C. & O. M. Co., Kanawha,	"	300
G. R. C. & O. Co, "	"	300
Grier, "	"	200
Staunton, "	"	200
Atlantic, "	"	200
Maysville,	Ky.	400
Union Co,	"	Unknown.
Covington,	"	Unknown.
Breckinridge,	"	250
Newport,	"	300
Eureka, Cincinnati,	Ohio,	600
Rosencrans & Co., Cinn.,	"	300
Phœnix, "	"	200
St. Louis,	Mo.	200
Otherwise,		3,500
Total number of gallons daily,		22,750

Some of these factories may produce more and some less, but the total, above given, is a tolerably close approximation to the actual amount produced at that time.

It is further estimated, "that from 250,000 to 300,000 dozen coal-oil burners and lamps have been constructed; of which 150,000 dozen are in use, and the balance in the hands of dealers."

"A coal-oil lamp consumes about four gallons during a year. Hence, the amount of oil burnt in these 1,800,000 lamps is about 7,200,000 gallons per year, or about 20,000 gallons every day."

This shows that already the amount manufactured is in advance of the quantity consumed.

To make 22,750 gallons of *burning* oil, requires 75,000 gallons of *crude* oil, which requires 60,000 bushels of cannel coal to produce it.

Since the wonderful discoveries of native "*rock-oil*" which have recently been made, the price of coal-oil has been greatly reduced, and the use of it, to a considerable extent, superseded.

On Oil Creek, in the vicinity of Titusville, in Pennsylvania, oil flows out from some of the wells and borings at the rate of 75 to 100 gallons in twenty-four hours, already fit for the market. At least 2000 wells are now in progress, and 200 of these are already pumping oil or have found it. The wells yield from 12 to 75 barrels, of 42 gallons each, per day, and the expense of running a pump is said to be not over six dollars per day.

We are informed by an article which appeared in the New York Evening Post, of the 29th August, 1860, that from the commencement, the demand for the oil has been in advance of the supply, and always brings

cash. Some men have made, in Pennsylvania, we are told, from $15,000 to $20,000, in five months, from single wells; and many land-holders have realized as much from their leases, which are daily coming more into demand, and more valuable.

The oil in these wells rises, in some instances, to the surface with water; in others, overflows in a stream of pure oil.

This oil is useful for various purposes; viz.: in medicine, for burns and bruises, and as a substitute for arnica, which it resembles in its medicinal properties; as a solvent of gums, gutta percha, India rubber, &c.; in the manufacture of gas; for lubricating; and finally, as an illuminating oil, preference is given to this native oil over all others. Already it is adopted, to a great extent, by the various railroad lines, and government has closed a contract for it to supply the light-houses on our coast.

It is said to possess twenty-five per cent. more illuminating power than the best coal-oil. Whether this is based on reliable, comparative experiments on intensity of light, I am not prepared to say. It has the advantage over sperm-oil in not chilling in the cold.

In the crude state, as it comes from the wells, this rock-oil is worth thirty cents per gallon.

So enormous a supply of native oil, at such a price, must, of course, affect materially the profits of a coal-oil business; both that produced from cannel-coal, as well as that from lignites. When the coal-oil business first started, crude oil was worth from seventy to eighty cents per gallon. I suppose now, it hardly brings twenty to twenty-five cents per gallon.

As some of the proprietors of lignite beds may desire to know the cost of manufacturing and refining oils obtained from coal, I here state that to manufacture and refine 1000 gallons of oil, in a large establishment, making from 1500 to 2000 gallons per day, the cost is from $135 to $150, or from thirteen to fifteen cents per gallon; but in small establishments, making only 200 to 300 gallons per day, the cost will not fall much short of twenty cents per gallon, unless the coal is remarkably rich in oil; that is, yielding seventy to eighty gallons of oil to the ton.

Where such establishments are remote from cities, the chemicals for the purification of the oil are necessarily high, and the price of labor dear, twenty-five cents per gallon is, probably, not too high a price to be put upon the cost of manufacturing and refining; hence, it may be seen that it is only large establishments, conveniently situated to markets, and those which can secure coals rich in oil, that can make much profit by the business.

When heavy lubricating oils and paraffine are manufactured at the same time, these will, of course, increase the income of the establishment, since these are not taken into consideration in the above calculation.

One of the most remarkable geological phenomena of Southern Arkansas, is the immense number and size of shells allied to the oyster family:

Exogyra costata and *Ostrea vesicularis*, which lie strewed and exposed where certain cretaceous beds, in which they were imbedded as fossils, reach the surface. So abundant are they, that they have become of considerable economic value. In many ploughed fields on farms, a few miles north of Washington and elsewhere in Hempstead County, they can be gathered by the wagon-load. I witnessed, myself, in that vicinity, a pile thrown together on a log-heap, preparatory to burning them into lime, which consisted of some fifty to a hundred wagon-loads.

Many of the *Exogyra* are so large as to weigh several pounds; one which I collected in Sevier County, was found to weigh four pounds six and a half ounces.

These fossil shells afford, when burnt, better lime than the argillaceous and marly limestones with which they are associated: since they are composed, principally, of carbonate of lime in nearly as pure a state as in most limestones; the greater part, if not all, of the animal matter having been removed during the process of fosilization and long interment.

The repeated and long-continued movements of the rocks one upon another, during the periods of disturbance and upheaval, of which we have abundant proof in Arkansas, have given rise to numerous and extensive drift deposits, composed mostly of quartz, the harder forms of sandstone, beds of sand, and disseminated fragments of slates and shale. These are often of such depth and extent as to conceal from view, for miles, the bed-rock on which they repose.

The local drift of Pulaski County, in and about Little Rock, is an example in point.

This drift has no connection with the northern drift, being due entirely to local geological phenomena, peculiar to the State of Arkansas; though the northern drift may have accumulated, in part, during the same period.

Some of this drift of Pulaski County, is made up of very coarse materials, and there are often, imbedded, large blocks of sandstone and quartz, of size and weight more than a man can lift.

The precise age of this drift it would be difficult to pronounce upon, as no fossils have yet been found which belong strictly to the era of deposit; but it is probable, that some of it is of comparatively recent date, perhaps as new as the date of the rise of the quaternary beds of the Western States out of the great lake-like expansions of fresh water in which they were accumulated.

Extensive beds of Gypsum or Plaster-stone, have been examined in a high bluff on the banks of Little Missouri River, on Sections 29 and 30, T. 8 north, R. 25 west, with which is associated crystallized selenite, limonite iron-ore, red and pink clays, and a bed of limestone, which will be more particularly noticed under the head of Pike County.

On Bacon and Brier Creeks, in the same county, there are fine beds of

gypseous marl, with crystals of selenite imbedded; and lower down in the former creek is a bed of lignite; but that which is visible above the waters of Bacon Creek is not of sufficient extent and thickness to be of much practical value.

On the latter creek are shell limestones, in considerable bodies, which will not only make good lime, by burning, but a valuable fertilizer when applied to land, either ground or in the burnt state.

Near the confines of Sevier county and the Indian boundary, there is an excellent quality of roofing slate, equal, if not superior, to the best Vermont slate, both as to durability, evenness of cleavage, fineness of texture, and beauty of color.

I have seen several other localities in Pulaski, Polk, Pike, and Sevier counties, where the surface-slate appears favorable for opening slate quarries, which will be designated in the sequel of this Report; but until a quarry is opened, a correct opinion cannot be formed of the fitness of a slate in all respects for roofing and other purposes for which slates are now in use. Some slates make the most beautiful hearths and table-tops imaginable, which may be seen in the new laboratory which I have just built. The hearthstones are of single slabs of slate, one inch thick, five feet long, and eighteen to twenty inches wide, jointed with the greatest accuracy. A table-top is made of two slabs, six feet and a half long, and two feet wide. These two slabs, forming the top of my chemical table, have a green, mottled color, resembling some serpentines, with a perfectly level surface, and smooth, almost to a polish. On account of this capability of furnishing a remarkably true surface, slate is now made use of for billiard-tables, in preference to any other material.

The applications of slate to various purposes in the arts, are therefore now so numerous, that good slate quarries are of great importance to a country, as well as to the owners of the property.

Various localities, worthy the attention of the iron-master, in which iron ores have been found, in the range of the Petit Jean, the Short Mountain, Fourche La Fave, &c., have been observed, and will be hereafter more particularly noticed in the different sections of this Report, under the head of Counties.

CHAPTER II.

AGRICULTURAL GEOLOGY.

THE SOIL AND ITS ANALYSIS.

In presenting to the farmers of Arkansas the results of the chemical analyses of the soils of the State, so far as they have been completed, it becomes necessary, in order to a proper understanding of the subject, and a just appreciation of the value of these chemical analyses, that I should impress on their attention, in this place, some of the general principles of agricultural chemistry, now fully established, both by theory and practical experiments, and admitted as established facts in the science of chemical physiology.

Nothing can be more important for the agriculturist than to understand of what materials plants are composed, and the source whence they are derived; what constitutes their food, and whence the stores of that food are drawn; how plants are nourished; what the farmer can do towards supplying the requisite nourishment; and what is appropriated by vegetation itself, without his aid or intervention, through natural operations in constant action.

The food of plants consists of those elements which are elaborated, by suitable organs, into the substance of the plant, and ultimately enter into the composition of their tissues, either through the medium of the sap which circulates in their vessels, or are imbibed or breathed through the pores of their leaves. These elements are now known to be derived from two distinct sources: the air or atmosphere which surrounds plants, and the soil in which the roots are fixed, and the plant sustained in its natural position. By far the most bulky and weighty part of plants is received from the first of these sources,—atmospheric air.

It is well known to every farmer that, if a stick is buried from twelve to twenty-four hours in red-hot ashes, and kept as much as possible from contact with the air, there will be found, in place of the log of wood, a black mass of charcoal, almost as bulky as the original stick of wood before charring. If this charcoal be now heated red-hot, with free access

of air, the greater part of it will be consumed, and only a small percentage of incombustible ashes remain.

In the first of these operations, a considerable proportion of volatile matters is driven off from the log of wood in the form of water, gases, a peculiar acid called pyroligneous acid, and, if the tree from which the log of wood was taken be of a resinous character, like pine, there will also be a large quantity of tar, besides other less important principles.

In the second operation, viz., the combustion of the charcoal, its black particles, *if thoroughly burnt, all disappear*, and are dissipated into the atmosphere as a colorless, transparent, heavy gas, containing all the combustible principles of the charcoal, which chemists call *carbon*, united mostly with one of the elements of which atmospheric air is composed,—oxygen, or generator of acids. Hence, the name of the resultant gas, *carbonic acid*, with which, as it plays a most important part in agriculture, every farmer should make himself acquainted. Though transparent and colorless, and therefore invisible, yet its presence can always be made manifest by its action on lime; for, if passed through clear lime-water, or a clear solution of sugar of lead (acetate of lead), it will immediately render these milky or turbid; because the carbonic acid gas unites, in the one case, with lime, in the other, with the oxide of lead, forming *carbonate of lime* or *carbonate of lead*, according as lime or lead may be present; and both the above-named combinations, being scarcely at all soluble in water, fall down as white, impalpable powders or precipitates. This gas is also known by its great weight, being about twice as heavy as common air, and, therefore, is disposed to settle down into low places. All of my readers are, in fact, acquainted with this gas under the name of "choke-damp," or the suffocating air which is frequently found in deep wells and pits.

I have been thus particular in directing your attention to this heavy, suffocating gas, because it is one of the principal materials out of which all plants separate the most bulky and weighty part of their substance, the carbon, to which I have already alluded as the combustible principle of charcoal. Carbonic acid, then, is one of the chief chemical compounds out of which plants build up a very large part of their tissues. Though vegetation may and does derive a portion of this carbonic acid from other substances with which it is combined, contained in the sap absorbed by the roots of plants, there is a *much larger portion* imbibed from the surrounding air, which always contains of it, in the present age, from $\frac{4}{10000}$ to $\frac{8}{10000}$ of its own volume, mixed everywhere around our earth with the other constituents of our atmosphere.

In its pure, unmixed state, this gas is very noxious to air-breathing animals; yet, when diluted or diffused in atmospheric air to the amount above named, it is not hurtful to the respiration of animals, while to plants it is *absolutely indispensable*. The green part of vegetables, under the

influence of the light of the sun, has, indeed, the power of imbibing, in fact, *breathing*, this carbonic acid (noxious to animals), and fixing therefrom the carbon, which, with water or the elements of water, constitute the main tissues of their structure. This will be appreciated on considering that woody fibre, the cellular tissue, the starch, and gummy substances are made up of nearly one-half carbon, and the other, or rather greater half, of water or the elements of water; and that these constitute, in reality, nearly the whole framework of vegetation. By this process, carbonic acid not only nourishes and builds up vegetation, which is to become afterwards the food of animals, but at the same time, our atmosphere is preserved in a pure or normal condition in respect to the proportion of carbonic acid present in it; for, being constantly thrown off by every expiration of all air-breathing animals, and generated by all combustion, fermentation, and decomposition of organic matters, besides being emitted from craters and fissures on the earth's surface, it would, in a very short time, accumulate to an extent injurious to animal life.

Thus, it is mainly by the alternate combustion and reduction, by which carbonic acid is produced and consumed, that the balance in the two kingdoms—animal and vegetable—is constantly maintained, and the normal constitution of the atmosphere preserved,—these functions not only preventing excess of carbonic acid from accumulating, but restoring to the atmosphere that oxygen or vital air, indispensable to animal life, which all air-breathing animals, during every moment of their lives, are appropriating from that very source. In other words, while vegetables assimilate carbonic acid, fix its carbon in their tissues, and expire its oxygen, they compensate by this oxygen for the loss of that principle sustained through the arterialization of the blood of animals.

Though carbonic acid is, then, an absolutely essential ingredient of all kinds of crops, yet the furnishing of it does not require particular solicitude on the part of the farmer in his farming operations; because, being universally diffused in the atmosphere from the numerous sources of supply enumerated, it continually bathes the green leaves of plants; or, as it is dissolved in most spring water, and in every shower of rain, it can easily be imbibed by the soil. This element is, therefore, always attainable.

Water, which forms, as already stated, more than one-half the substance of plants, it is not necessary to dwell on here, except to remind the reader that there is an incessant change of its constituents—oxygen and hydrogen—taking place, both in the economy of plants, during their life, by which, in combination with carbon, a number of proximate principles are formed; such as sugar, starch, glutin, dextrine, gums, oils, &c., and after death, by the process of decay, when these are again resolved into carbonic acid, water (and some gaseous substances of less importance to agriculture); thus water and its elements are again restored to the atmosphere whence they came.

It ought to be remarked, however, that water is not only of importance to plants, as furnishing elements of nutrition, but is the almost universal solvent or medium by which various other substances are carried into the circulation of plants, especially impregnated, as it always is, more or less, in the soil, with carbonic acid. As with carbonic acid, the atmosphere is the great source whence water and its elements are supplied to vegetation.

This also is, undoubtedly, the original source of another important element of vegetable life, called *Nitrogen*.

Experiments, it is true, go to prove that our most nutritive grains, as wheat, oats, and rye, derive a large proportion of their nitrogen from organic matters of soils, and from manures; yet, it is highly probable, that the primitive vegetation appropriated nitrogen from the atmosphere, as Boussingault has shown to be the case with artichokes, trefoil, and some other plants. Besides, when we come to consider that there could be no source of nitrogen from manure, until vegetation had accumulated to a certain extent, it is clear that it must have been derived, originally, from organic nature, of which the atmosphere is by far the most likely source.

Ammonia and nitric acid are regarded, by many chemists and physiologists, as compounds dispensing nitrogen to plants; but this does not militate against the preceding views, since both these exist in small quantities in the atmosphere; the former evolved from the decay of organic matters, and from the combustion of certain substances; the latter being regarded, generally, as a chemical union, which takes place of some of the atoms of oxygen and nitrogen of the atmosphere (in the proportion of five of oxygen to one of nitrogen) during the passage of lightning, or electrical discharges, through the air.*

Though ammonia and nitric acid are admitted by all as acting the part of powerful manures, yet, as Boussingault remarks, it cannot, from his experiments, be affirmed, positively, that the nitrogen of the air takes this form before becoming fixed in the substance of plants; and G. Ville's researches seem to prove that part of the nitrogen of plants does not assume either of these forms in passing into the substance of plants, but is taken directly from the atmosphere.

Further; although nitrogen enters into the composition of plants in smaller proportions than the previously-mentioned elements, carbon and oxygen (viz., in the proportion, on an average, of only fourteen to eighteen

* G. Ville, of Paris, has recently instituted some researches on this subject, from which he concludes that all the plants he tried had the power of assimilating more nitrogen than was contained in the ammonia and nitric acid which was supplied to them in the air. So that, according to his experiments, even the cereals can absorb nitrogen from its state of atmospheric mixture,—an opinion which I have long entertained,—reasoning from general principles of the gradual progress of vegetation, from the time of the carboniferous period up to the present time.

per cent), still it is found to be an essential element of every plant, entering especially into the composition of the fibrine, albumen, and caseine, which are characteristic proximate principles of the most nutritive parts of plants.

It is these nitrogenous principles of plants which form, in fact, the plastic principles of the blood and muscle of animals.

These chemical and physiological facts have most important practical bearings on all farming operations; and therefore I desire to impress them firmly on the recollection of my agricultural readers.

Inasmuch as nitrogen is so important an element in the composition of nutritive grains, like wheat, oats, and rye, and these plants seem to have less power of appropriating it directly from the atmosphere, but it is rather afforded by natural or artificial manures already contained in or introduced by the hand of man into the soil, in the form of barn-yard manure, excrements, urine, guano, poudrette, ammoniacal or nitric acid, salts, &c., it is evident, that when such grains are cultivated, if there be not already a sufficient supply of nitrogenous principles in the soil, the farmer must take means to supply it; either by the application of some of the above-mentioned manures, or by preceding the crop of these grains by some other crop which has a greater power of fixing nitrogen in its organization, from the atmosphere, either directly or through the medium of the nitrogenous compounds, ammonia and nitric acid, and which crop, when turned in, will supply the place of manures by yielding up its nitrogen to the succeeding crop. This latter plan is usually the most feasible one in the West and South, where stock being seldom housed, and the dung-heap generally suffered to lose much of the fertilizing principles by exposure to rain and the heat of the sun, without employing the necessary means to fix the ammonia, this gaseous product, being extremely volatile in the usual condition in which it is produced by the fermentation of organic substances, rapidly escapes into the atmosphere, as soon as the manure begins to heat or decompose.

The operation of manuring is generally the most expensive and laborious part of the business of the agriculturist. How important then is it for his interest, that he should thoroughly understand its principles, and the manner of accomplishing it in the cheapest and most economical manner! And much important information can be acquired by the farmer, simply through a practical understanding of the foregoing facts.

All the substances before enumerated, which form the most bulky and weighty part of plants, have been designated the volatile or atmospheric elements of vegetation; *volatile*, because either by rapid or slow decomposition of all vegetation, they are evolved as gaseous products, and because they are derived and ultimately returned by decomposition, either directly from vegetation, or after having entered into the organization of animals, to their original source, the atmosphere.

There is, however, another class of substances, more numerous than the preceding, which belong essentially to the constitution of plants, because, without them, no plant can come to perfection. Though they exist in plants in very small quantities compared with the volatile or atmospheric elements, they are of paramount importance to the farmer, and demand especially his fostering care; because, being constituents *of the soil only*, or of the rocks whence the soil has been derived, they are, by being taken up and entering into the organization of plants, removed from the soil *by every harvest*. A farm, therefore, becomes exhausted of these substances sooner than of its other elements of production, and will proportionally decline in fertility. These are the earthy or fixed constituents of plants, which remain as incombustible ash, after the dissipation of their volatile elements, and their diffusion in the atmosphere.

It is these substances which a useful chemical soil-analysis ought, mainly, to set forth, all being separated, one by one, from the soil, and their weights recorded with the greatest exactness. Herein is comprised the great art of the process. And, principally, from chemical soil-analyses, can the agriculturist form an intelligent opinion as to the comparative fertility of soils, and their suitability to the growth of certain plants, as well as judge what application may be required in the way of lime, phosphate of lime or bone-earth, sulphate of lime or plaster of Paris, ashes or salts of potash, or soda, &c.

There are eleven of these substances which can be separated from most soils, viz.:

Silica,	Oxide of manganese,	Phosphoric acid,
Lime,	Potash,	Sulphuric acid,
Magnesia,	Soda,	Chlorine.
Oxide of iron,	Alumina,	

Six of these are more important than the rest: Phosphoric acid, Lime, Potash, Soda, Alumina, and oxide of Iron.

Of the volatile elements, Carbon, Oxygen, and Hydrogen,—everywhere diffused, and constantly bathing the organs of plants destined to appropriate them as nourishment,—vegetation has always an unfailing supply without the aid or intervention of the farmer.

This is true, also, to a certain extent, of Nitrogen, which, in the form of Ammonia, is more or less disseminated in the atmosphere, or available in the form of Nitric acid, which is produced chiefly during thunderstorms, by the electric discharges passing through the air, especially in the presence of Potash and Lime in the soil or elsewhere on the earth's surface, these combining with the newly-formed nitric acid.

Not so with the fixed mineral constituents of plants, disseminated in the soil, from which it is taken up by the roots of plants, either by the

solvent power of water, charged with carbonic acid, or some organic acid, as humic, crenic, and appocrenic acid; or, according to Liebig, not in solution, but by some assimilative power possessed by the terminal rootlets of plants, which he has not yet clearly explained.

Every crop put into the ground which comes to perfection, and, indeed, every plant or weed that comes to maturity, appropriates more or less of this mineral food stored up in the soil; and every crop which is harvested, and sold off the farm, exhausts the soil, to a certain extent, of these mineral fertilizers, which, if not restored by the labor of the husbandman, by the application of natural or artificial manures, or by further disintegration of new particles of the soil, or of the adjacent rock-formation, is just so much permanent deterioration of the soil.

To illustrate how important some of these fixed earthy constituents of plants are to the perfecting of grains and grasses, and to the nourishment of animals feeding on them, it is sufficient to state that the two substances, Phosphoric acid and Lime, form, with gelatine, the principal substance of the bones of all animals: these they derive from plants; and plants have no means of obtaining their supply, except from the phosphate of lime in the soil. Without bones, no quadruped, bird, reptile, or fish, could exist: they are the axis of support, and constitute the case of protection for those vital organs, the brain and spinal cord; they are the levers and fulcrums of all animal motion; they give attachment for the tendons of the muscles, which, by their contraction and relaxation, set these levers to work, animated by the nervous fluid, distributed from the brain and spinal marrow. This phosphate of lime is appropriated by plants most abundantly during the formation of the seed. It is the grain forming the food of animals, in which this substance resides in larger proportion than in any part of the plant.

Almost every kind of cultivated plant contains more or less of all the eleven bases and acids above enumerated; but they exist in very different proportions in different plants. Wheat requires a larger proportion of phosphoric acid, potash, and magnesia, than any of the other ingredients; Clover requires a large proportion of lime and potash; Corn and Buckwheat require a large proportion of phosphoric acid, soda, and potash; each plant having its own particular proportion, but containing more or less of each one of the nine to eleven inorganic substances previously enumerated, which it appropriates from the soil, and which are essential to the perfection of the plant; that proportion varies also in the seed, leaves, and stalk of the same plant. No plant is capable of sustaining animal life if these substances do not form a part of their composition; and if the food of animals is deficient in them, their bones will have no stability, and be incapable of sustaining the weight of the body, the digestive and biliary functions will be impaired, or some other defect or disease will be the con-

sequence. Hence, though always in small proportion in even the most nourishing plants, they must, nevertheless, exist in them.

These being now well-established facts in agricultural chemistry, and in the physiology of plants and animals, I proceed to explain in what way soil-analysis becomes of value to the farmer. And I desire to call particular attention to this subject, because the opinion has been expressed, even in this very year, and by those having a high standing in the scientific world, that chemistry is incapable of conveying any useful information to the farmer by analyzing his soil.

Any one who will take the trouble to inspect carefully the analyses of the one hundred and eighty-seven Arkansas soils, made by Dr. Robert Peter, in connection with the Agricultural Department of the Geological Survey of the State, and recorded both separately and in tabular form, will see that the relative proportions of the eleven mineral constituents of these soils is very accurately given. He will perceive, moreover, that the relative proportions of these constituents varies in every soil, subsoil, and underclay.

Recollecting that these soils were collected during the geological survey, with special reference to the derivative geological formation, he will take notice, that these analyses most distinctly show, that certain geological formations impart to the soil more of the important mineral fertilizers than others; and if he will take the trouble to look over the two hundred and two soil-analyses in the three volumes of the Kentucky Geological Report, already published, he will be able, from the increased number of comparative analyses there given, to see that it is those formations which are composed of easily disintegrating materials, more or less calcareous, and charged with fossil shells and zoophytes, which, all other things being equal, yield the soils richest in phosphoric acid, lime, and potash; and, at the same time, contain the quantity of alumina and oxide of iron necessary to render them sufficiently retentive and attractive of atmospheric water and ammonia; therefore, these soils are the best adapted for those grains and crops which require the largest proportion of these ingredients. This he learns from an inspection of the tables appended to this Report, giving analyses of the ashes of different plants.

He will, moreover, be able to trace the gradual diminution in the proportion of the most important mineral ingredients, down from these extraordinarily fertile soils, derived from the highly fossiliferous, argillo-calcareous beds of the lower silurian, the cretaceous and the tertiary systems of the West; through the silico-calcareous soils of the upper silurian, devonian and subcarboniferous limestone, strata in which fossils are either more sparingly distributed or, in some cases, almost wanting, and which are far less easy of decomposition; thence, through the argillo-silicious soils of the coal measures, with only locally organic remains, and these chiefly of plants, down to the more purely silicious soils, prevalent where the non-

fossiliferous sandstones of the coal measures and of the millstone grit prevail to the exclusion of either shales or limestones; which afford the most unproductive soils as yet analyzed.

With the table of the composition of the ashes of plants to refer to, appended to this Report, and after becoming acquainted with the usual proportion of mineral constituents in an average soil, information which is easily acquired by looking over the table of soil-analyses in this Report, it is easy for any individual to see, when he is provided with a reliable analysis of his soil, not only to what crop it is best adapted, but what kind of mineral fertilizers, if any, it requires as a manure, and how it compares in fertility to the various grades of soils from other farms and other States. Is not this knowledge of some value to the farmer? Again, the soils collected, as well during the geological survey of Arkansas, as of Kentucky, have been, wherever it was practicable so to do, selected in sets of three or four: No. 1 being the virgin soil, which has never been in cultivation; No. 2 the same soil from an old field; No. 3 the subsoil from the same old field; No. 4 the under clay. The object of this selection was to ascertain, whether soil-analyses were capable of showing the ingredients, and the proportion of these removed by a long series of years of cropping.

With a few exceptions, the loss sustained by the soil by the removal of mineral fertilizers, with a succession of crops harvested during from ten to fifty years has been very distinctly shown, where there has been no return of these ingredients by natural or artificial means.

The exceptions are, in most cases, where the soil of the old field has been receiving acquisition by overflows of saliferous silt, by being mixed with a subsoil or under clay containing more of the mineral fertilizers than the surface soil itself; or where it was difficult to obtain, under equal conditions, a fair sample of the virgin soil, as will be shown hereafter.

Now, though it may be impossible for the chemist to show with his most sensitive balance, in the small sample of soil employed in the analysis, the infinitesimal amount of ingredients removed by a *single* crop, it *is possible*, by a judicious selection of virgin soil, and the same soil from an adjacent old field, cropped from ten to fifty years in succession in grain, to exhibit by carefully conducted chemical analyses of the two samples, the loss sustained by the removal of so many crops; and, having ascertained this, say for twenty-five years, by a simple calculation of proportions, an approximation at least may be made towards the *annual* loss of mineral food of plants, even if infinitesimal, and carried out to the millionth decimal.

I, for one, am not willing to subscribe to the doctrine, that chemistry is incapable of revealing the secret workings of vegetable growth, and giving to the farmer *useful* and *practical* information in regard to the management, renovation, and preservation of his soil. And if, by these researches, our farmers can become imbued with the true spirit of *restorative* farming;

that is, of the absolute necessity of giving back to their lands, in some shape or form, the mineral food of plants of which they rob the soil at every harvest, a real boon to mankind, and especially to future generations, will have been bestowed.

So long as standard agricultural works, and leaders in agricultural societies hold out the doctrine, that tillage is a *substitute* for manure, and that the rocks can restore the exhausted elements as rapidly as they are removed by agricultural operations, we shall have a continually progressive drain upon the future resources of our soils, no matter how deep we plough, how much we subsoil, how much we underdrain, or how perfectly and thoroughly we may till, because there seems to be a natural repugnance in our farmers to expend time, labor, or money either in saving manures or in carrying them on to their land; and so long as they are encouraged in the idea, that their land can be kept in good heart, *i. e.*, in its normal condition, by tillage and the natural crumbling of rocks it cannot be expected that any steps will be taken to arrest the inevitable exhaustion which all land sooner or later must undergo, by a succession of harvested crops, whether of grain, grasses or roots, if no means be taken to restore to the soil the mineral food of plants.

I only know of one kind of geological formation in the Western country, that is composed of materials which disintegrate with a rapidity in any way adequate to keep pace with the average exhaustion produced by continual cropping, and this is the incoherent, soft, fossiliferous shell-marl, intercalated in some portions of the "Blue Limestone Formation" of Kentucky, of Lower Silurian date. As a general rule, the crumbling of rock to soil is a process so slow, particularly in the majority of cases, where the parent rock lies deeply buried beneath soil, subsoil, and under clay, as to be inappreciable in a generation.

In the Old World, where it is often difficult to obtain a really virgin soil, and where the old fields, from absolute necessity, have been usually manured through several generations, it would be far more difficult to make the selections of soil to demonstrate the loss by repeated harvests, than in the United States; since here we have not only an abundance of virgin soils, but we can meet daily with old fields that have been in cultivation for fifty and even sixty years or more, without having ever received a cartload of manure.

In a new State like Arkansas it has, of course, been more difficult to demonstrate by the comparative chemical analyses of the virgin soil, and from fields a certain number of years in cultivation, the loss by cropping, than in the older State of Kentucky. Nevertheless, out of fifty-nine different cases recorded in the Chemical and Agricultural Report, forty-three of the soils from old fields exhibit a decided loss by cropping; and many of the exceptions are cases of alluvial lands which are receiving acquisitions,

either by overflow, or by a process of refertilization which I am now about to explain.

In many of the cotton plantations on the Arkansas River the waters of that stream, even when they do not rise high enough to overflow its banks, yet permeate from beneath upwards, which is proved by the rise and fall of the water in the wells corresponding to the rise and fall of the river, through porous places, so that during high water the under-layers and sometimes the subsoil become saturated with water. In such situations the substrata become more or less fertilized. It is a well-established fact in agricultural chemistry, that if water impregnated with acids and bases, that serve as food for plants, be filtered through a sufficient stratum of any soil, the water will pass out below with hardly a trace of these substances in it, because the soil, during the passage of the water charged with this saline matter, has the power of appropriating and fixing these constituents held in solution. No matter whether the impregnated water enters from above or below, the effect will be the same.

It has been demonstrated by the quantitative chemical analyses of the waters of the Arkansas River, of the springs and of the well-water of that country, that they contain notable quantities of Carbonic acid, Chlorine, Sulphuric acid, Lime, Magnesia, Alumina, Potash, and Soda,—the river water being more strongly impregnated with chloride of sodium (common salt), salts of lime, and magnesia, than even the well water. Furthermore, it is well known that in certain rises of the Arkansas River, especially those that take place in June, the water of that stream is almost as red as blood, from the quantity of suspended fine ferruginous clay and saliferous silt,* brought down from the regions of ferruginous shales, which prevail in that noted salt region, beyond the limits of the State, in the Cherokee country, through which the Arkansas River flows. This fine red saliferous mud is evidently the material, which, being deposited in the eddies and still water, produces the celebrated "red buck-shot land."

The Arkansas River washes, also, near the confines of Jefferson and Pulaski Counties, bluffs of argillaceous shell-marl of tertiary date of most easy disintegration. The fine mud, calcareous matter and phosphates, of which these argillaceous marly beds are composed, are washed down by the current of the Arkansas, sweeping against its banks, and are carried by degrees, to be redeposited at greater or less distances along the river-banks, imparting extraordinary fertilizing properties to the soil receiving such acquisitions; but, not more so than the red saliferous silt, already spoken of, coming from higher up the river.

Now these fertilizers can be distributed over and through the bottom soils and subsoils not only from above, but by permeating from beneath;

* When the waters subside after such rises saline efflorescences are said to be visible on the edge of the receding water.

and it is probable that during the present epoch the fertility of alluvial lands of the great river of Arkansas are kept up more by the latter than the former process. The imbibition or permeation from beneath has, moreover, this advantage, that there is no washing away of the old soil, nor incursion of loose white sand, liable to take place locally during seasons of high overflow.

It is by these accessions that the normal or standard fertility of these lands is kept up, so that cotton has been grown on them for twenty or thirty years in succession; yet little or no deterioration is manifest, either by chemical analyses or by diminished crops, even with ordinary tillage. Indeed, in the case of soils Nos. 333 and 334, the analysis of which is recorded in Dr. Peter's Report, the cultivated soil No. 334 has lost only 0.054 of phosphoric acid, and 0.017 of sulphuric acid; while it has gained, by the process just explained, no less than 0.266 of potash, and 0.075 of soda. Now, since it is a well-established fact, that cotton grown on the sea islands, or within ten miles of the sea, has a much longer and finer staple than any of the inland cotton, it appears very evident that the alkalies, soda and potash, found in large quantities in sea-water, and even mechanically suspended in the air of the sea-coast, must contribute greatly to the perfection of its growth. From which it is a fair inference that the acquisitions in potash and soda, which the soil imbibes from the waters of the Arkansas River, as well as from the alkaline waters so prevalent along its borders, are, indeed, the cause of the peculiar adaptability of these alluvial lands to the growth of cotton.

The same remarks apply to the alluvial lands of Red River, which are of the same nature, and which receive with the annual floods fine, red, saliferous silts, of equally fertilizing properties.

The preceding remarks explain also why the analysis of soil No. 358 shows more potash and phosphoric acid than the virgin soil No. 357, together with the fact that the former contains a small proportion more ferruginous clay than the latter.

In ancient times, and, I presume, even at this day, the overflow of the Nile was watched with so much interest that stations were established along its banks, with the primitive telegraph of those days, for the purpose of transmitting intelligence, hour by hour, of every inch of rise and fall of the Nile; because, the inhabitants, aware, from long experience, how much the silt of the Nile contributed to the fertility of their alluvial lands, great anxiety was manifested to learn in advance the progress of the flood.

The small excess of potash and soda in the soils of the old fields, Nos. 226, 235, 238, 364, 359, 316, and 361, have, no doubt, been derived, either from the subsoil, in which the comparative analysis shows them to exist in larger proportion than in the virgin soil, or from fresh disintegration of the larger quantity of clay than in the surface soil.

The larger proportion of potash in soils Nos. 322, 313, 338, is to be accounted for in the same way.

The ferruginous clays sometimes existing in larger quantity, either in the soil of the old field, or in the subsoil, evidently also supplies sometimes not only potash and soda, but occasionally phosphoric and sulphuric acids to fields, as fast as it is removed by crops; particularly with good tillage. This has been the case, probably, with soils Nos. 295, 401, 313, 374. Even a slight increase of clay itself will supply these, particularly potash, as seems to have been the case with soil 301.

One or more of the acids and bases in soils may be derived, as has already been explained, by overflow or saturation of the subsoil and under-layer, by high stages of water not sufficient actually to overflow the land. This has been the case with soils Nos. 358, 330, 346, 380, 374, 354, 232, 383, 229.

In the case of soil No. 286, in which the chemical analysis shows more soda, potash, and phosphoric acid, than the virgin soil No. 285, the apparent exception to the general rule cannot be altogether satisfactorily explained except by original difference in the soil; though even in this case the larger proportion of potash may be derived from the subsoil No. 287, which contains not only more of this base, but also more clay than the virgin soil. This is one of the very few cases in which the larger proportion of acids and bases in the soil of the old field cannot be quite satisfactorily accounted for in the acquisitions received from the various sources above mentioned; so that they do not militate against the general inference deduced from these comparative soil-analyses, that chemistry is capable of showing the *exhaustion of land* by continual cropping.

It is worthy of note in this place, that many of the cretaceous soils, especially those from old fields, show a remarkable excess of carbonate of lime; as, for instance, soils Nos. 367, 366, 327, 344, in which the carbonate of lime amounts to from thirty-five to even sixty-six per cent. The effect of this excess of carbonate of lime is to rapidly exhaust the soil of organic principles by rendering them soluble, and thus putting them in a condition to be readily appropriated by plants. This is the cause, operating together with the tendency of the cretaceous soils, based on slippery argillaceous calcareous clay or chalk marls, to wash down into the low situations, that we so often meet with "bald" places on the ridges and slopes where the bare substrata are exposed. Such places are almost barren until well tilled and thoroughly manured.

I desire, in this place, to call the particular attention of Cotton Planters to the analysis of the ashes of both cotton fibre and cotton seed made for this Report by Dr. Robert Peter, from specimens collected by myself on the plantation of Messrs. Farrelly and More, near the Post of Arkansas,

	In 100 parts. Cotton fibre.	Cotton seed.
Potash,	0.388	0.620
Soda,	0.028	0.310
Lime,	0.138	0.159
Magnesia,	0.185	0.698
Phosphoric acid,	0.125	1.600
Sulphuric acid,	0.096	0.092
Chlorine,	0.024	0.060
Sand* and silica,	0.457	0.120
Carbonic acid and loss,	0.254	0.111
	1.697	1.697

From the preceding chemical analyses it will be perceived that both the fibre and seed contain, in all, nine fixed constituents in the ash; that the substances, which both the fibre and seed appropriate the most of from the soil, are phosphoric acid, potash, soda, magnesia, and lime; and therefore these are the substances of which it exhausts the soil most.

It will be observed, moreover, which is a most important result of these chemical analyses, that the seed contains more than twelve times as much phosphoric acid, more than fourteen times more soda, and nearly twice as much potash, as the cotton fibre.

Hence it is most manifest how necessary and important it is for keeping up, to some extent, the fertility of the soil for cotton, to restore the seed to the land, in place of allowing it to ferment, rot, and pollute the air with unwholesome emanations. Further, wherever opportunity offers, the oil should be extracted from the seed before returning it to the land; because it is capable of producing an oil which, by the proper method of purification, can be made as clear as water, and as tasteless as the best olive oil, and therefore fit for table use, while it is also extensively applicable in the manufacture of soap. Yet, after the extraction of this oil, the seed-cake as a manure is nearly as valuable as the unpressed seed.

To leave the seed, therefore, heaped up to decay and putrefy is a double loss, while it certainly is a very great nuisance, and must be prone to create sickness.

* In both cotton fibre and seed, but especially in the latter, there was a notable quantity of *sand*, included under the head of *Sand and Silica* in the above statement, which should have been excluded, but was inadvertently neglected.

CHAPTER III.

ARTESIAN WELLS AND CISTERNS.

Numerous instances will be cited in the sequel to this Report, where, in consequence of the well and spring water being too highly charged with certain mineral constituents, it has been recommended to construct capacious cisterns for the reception of rain water, such being far more wholesome for constant domestic use, particularly when collected from clean roofs during the winter season.

On many plantations, especially in the southern part of the State, it may also become advisable, under certain circumstances, where large supplies of water are required, to sink artesian wells. For this reason I have been requested by Governor Conway to give, in my Geological Report, as much general information in regard to the construction of cisterns, and to sinking artesian wells as might be consistent with such an occasion. In regard to the construction of cisterns, it is seldom necessary to do more than dig a hole of appropriate size, in a convenient situation, with a flat bottom and circular or jug shaped walls, closing in the top of the reservoir with a well-constructed arch of sound brick or good building stone, leaving only a round aperture of, say, two feet and a half, for the reception of a chain or other pump, windlass and bucket, or such other means as may be convenient for drawing the water. Into this arch, a little above the general level of the surface of the ground, a copper or galvanized iron-pipe should be inserted to carry off the waste water; and the aperture of the arch should be finished off with a broad and strong wrought or cast iron ring, built firmly in with the brickwork.

The interior is then lined with two coats of hydraulic cement, and the fresher this is the better. This cement is always mixed with sand previous to use, and usually in the proportion of one part of hydraulic cement powder to two parts of sharp sand. If it is wished to be particular in having the firmest cement, it is advisable to wash the sand previous to mixing, particularly if not pure, to remove particles of clay or mud detrimental to the chemical union of the silex with the lime; for the setting of hydraulic cement is due to the formation of a silicate of lime, which resists

the action of even standing water; indeed, the best hydraulic cements will set even under water. The cement is applied after the manner of plastering a wall, and the quicker it is done the better. The cement ought to be allowed to dry a few weeks before water is let into it; unless it is very superior hydraulic cement, such as is seldom found in our market. The pipe which conducts the water into the cistern should be of good diameter, *i. e.*, abundantly large to carry off all the water collected from the roof, and it is well to let it terminate in a tin pan with a perforated bottom, to catch all leaves and rubbish floated in with the water through the conducting pipe. Indeed, it is well to make this strainer large enough to receive coarse sand or small gravel, and coarsely powdered charcoal, which more thoroughly purifies the water than a simple strainer.

It may be found necessary in some cases, where the subsoil and under clay consist of very incoherent sand or loose gravel, to wall up the pit with brick before applying the cement, in order to avoid the disagreeable mishap of the sides of the reservoir cracking or caving in. There are very few situations, however, even in alluvial lands, where this is found necessary. Of course, the cistern should, if possible, be out of reach of overflow; in situations, however, where it is necessary to construct cisterns on river bottoms, this is not always possible. In such cases it is the more necessary to have the best kind of cement and a strong wall.

In the first volume of this Report, several localities of hydraulic limestone have been mentioned, and others will be given in the sequel to this Report. It may be well, however, for me, in this place, to give the external physical characters by which hydraulic limestones may be recognized in their native bed.

Hydraulic limestones are, in the first place, more earthy in texture, and much more prone to crumble and decay by frost and the vicissitudes of the weather, than pure limestone, on account of the earthy silicates which enter into their composition. For this reason, they always show rounded edges on the weathered beds of stratification. The broken off fragments have what is called a "conchoidal" fracture, *i. e.*, hollowed out like a flat shell; they have often an argillaceous odor when breathed on, and are softer and more easily cut with edge tools than a pure limestone, especially after exposure.

Finally, when broken into small lumps and brought to a good, full, red heat on a fire, and then, when cold, water applied, it does not slake like burnt pure limestone; but on the contrary, after being taken from the fire and cooled, ground to powder, mixed with two parts sharp sandstone, and kneaded into a ball or cuboidal block, it may be set in a tumbler, and water poured over it without its crumbling down, as ordinary burnt lime would do, if treated in the same way; and it will even get harder the

longer it is left under water, if it is good hydraulic cement, and has been sufficiently burnt.

These are the criterions and tests by which water limestones may be always recognized and proved, if necessary.

It requires about one barrel of water cement to build a cistern to hold thirty barrels of water. The cost of a barrel of cement, on the lower Ohio River, is two dollars fifty cents to three dollars per barrel. The total cost of a thirty barrel cistern is about twelve dollars.

ARTESIAN WELLS.

Boring artesian wells is, of course, a far more serious and expensive operation than building even capacious cisterns. If the rock is near the surface, an artesian well may be commenced by digging a cylindrical well down to the rock through the soil, subsoil, and other loose materials. But, as a general rule, borings are made even through these loose materials down to the solid rock, the size of the hole being usually from four to five inches. In all cases the boring must be tubed up, otherwise the sand, gravel, and clays would wash in, and obstruct further operations. When the tubing has reached the solid rock, it must be firmly fastened into it, otherwise the sand and clay would wash in under it.

After the solid rock is fairly penetrated, and the tubing securely fixed, the next operation is to drill a perfectly perpendicular hole in the rock, and as cylindrical as possible, by means of well-tempered chisels (drills or bits), which are various in form, and sometimes complicated in their mechanical contrivance. To enter into a detailed description of these would be out of place on this occasion. The chisel is usually attached to poles of hickory or white-oak or some other strong fibrous wood, which are generally from thirty to thirty-three feet in length, and made to screw together by means of iron coupling-screws, with which the poles are shod at either end, so that they can be quickly and readily put together and taken apart. Sometimes the chisel has merely a strong wooden handle, and performs its work after the Chinese method, merely by the mechanical abrasion of the rock, produced by the simple weight of the chisel, as it is rapidly and repeatedly liberated from and seized by a grappling iron attached for that purpose to the bottom of the lowest rod.

The size of the boring depends very much upon the particular circumstances of the case; but the most common, and, perhaps, the most suitable for most cases, is three inches, or three and a quarter inches.

The cost of boring depends very much upon the size of the hole and the nature of the rock to be penetrated. In hard silicious rocks and flinty limestones, it is much more expensive than in ordinary sandstone, slates,

and shales. On an average, it may be put down at the rate of a dollar and a half to two dollars per foot for the first three hundred feet; but if, in a region where a small steam-engine is available, as in the valley of the Kanawha, fifty cents a foot is considered an average price; beyond three hundred feet, down to a thousand, the average cost may be set down at one dollar and twenty-five cents to one dollar and fifty cents; and from a thousand to fifteen hundred feet, at one dollar and fifty cents to two dollars.

When borings reach over three hundred feet, it is always best to employ steam-power, if available; if not, horse-power may be substituted.

After the solid rock is fairly penetrated, it is seldom necessary to insert any further tubing, as the solid rock forms itself a sufficiently stable tube. In some cases, where incoherent shales, or other unstable materials are penetrated between the more solid rock, partial tubing is found necessary through such materials, to prevent the washing in of the soft, adjacent debris; or in order to tube out lateral flows of local water which may be found necessary to be kept out of the boring.

The precautions necessary to be taken, in order to make a successful boring, are: first, to employ careful workmen, who will take particular pains to secure the aperture, and prevent tools and rubbish falling into the boring, and keeping it plumb and true; secondly, to use only strong and well-made tools, for breaking tools in the borings often leads to great expense and delay, which might have been avoided by having used at first more substantial tools; thirdly, to use the proper shaped drill, so that the hole should always be as cylindrical as possible. In all cases it is necessary to erect a stage, to secure and raise the weight of sinker and poles, which, in its simplest form, consists of four forty-foot poles, well braced and fastened together. This stage should be covered by a shed. A stage or shed-cover will cost from ten to twenty dollars. If a steam-engine is used, this stage has to be stronger and better secured, and will cost from thirty to seventy-five dollars.

From an estimate received through the kindness of J. P. Hale, Esq., of Kanawha, it appears that the cost of a set of substantial boring-tools, required for five hundred feet, will come to from one hundred and thirty to one hundred and forty dollars, including bits, sinker, poles, &c.; and from twelve dollars and fifty cents to fifteen dollars for each succeeding hundred feet.

If several wells are to be bored in the same neighborhood, the best and most economical plan is to employ an experienced borer, well known for his skill and thorough acquaintance with the business, to contract for the artesian well at so much a foot. By the time he has bored several wells, any man of ordinary ingenuity could learn, and undertake with his own hands to make successful borings.

Both copper and iron tubes are employed in tubing borings; but copper is by far the best. Cast iron is very commonly employed, but is objectionable, both on account of its brittleness and its liability to be corroded. Wrought iron tubing is much better, but still not so good as copper. The cost of copper tubing is about double that of cast iron; namely, from seventy-five cents to eighty cents per foot for two inch tubing; while iron tubing, of the same size, costs from thirty-five to forty cents.

Cast iron tubes made to screw together in lengths of from ten to thirteen feet, are often used for surface purposes, *i. e.*, down to the solid rock.

The time required in ordinary cases to sink three hundred feet by hand, will be five to six weeks; by steam, one week.

Sometimes it may become necessary to ream out the hole to a larger size than the first boring, for the insertion of partial tubing; or it may become desirable in order to obtain a larger body of water. It is always better, however, not to bore, at first, of greater diameter than is absolutely necessary, in order to avoid unnecessary cost, both in the boring and tubing operation; as the boring, at any time, can be enlarged by the reaming process.

At Kanawha, in Virginia, the ordinary method of preparing a salt well, is to bore a hole, say three inches in diameter, and one thousand feet deep; the top is then reamed down two to three hundred feet, five inches diameter. This is to receive the pump and pump-chamber at the lower end. Below this five-inch hole, the well is again reamed down to three hundred feet, about three and a half inches diameter, leaving an offset in the rock at each contraction of the boring. A copper pump, four inches in diameter, is inserted into the larger or five-inch hole, and two-inch copper tubing is fitted into the three and a half inch hole, with a "bag" on the lower end of the tube, resting hard on the offset. This is in order to shut off all the fresh or weak salt-water from above, while the strong salt-water is admitted from the lower depths. This pump and tubing are put together by screws, in lengths of twenty-five feet.

This extra-reaming, pump, and tubing is, however, unnecessary where there is no lateral water to shut off, and where water of the kind required rises freely in the boring to the surface.

I am indebted to J. P. Hale, Esq., of Kanawha, for these particulars in regard to the plan of sinking salt-wells in that valley, as well as for the following facts, in regard to boring-tools. That gentleman has had extensive experience in the manufacture of salt for thirteen years, and has had to bore several salt-wells from eight hundred to a thousand feet deep. In order to inform himself as to the cheapest and best mode of boring, he attended the Great Industrial Exhibition at London, in 1851. There, as well as in several countries on the continent of Europe, he examined carefully the boring-tools, and saw many in operation. Many of these tools

were very complicated; most of them very expensive, so that after an examination of all of them, Mr. J. P. Hale became satisfied, that, for simplicity, economy, and efficiency, there are no boring-tools equal to those made and used in the valley of the Kanawha.

It may be useful and interesting in this place, to say a few words in regard to a few individual artesian wells of particular interest, either on account of their great depth, their large diameter, or the great volume of water which they afford.

One of the most interesting artesian wells bored in the valley of the Ohio, is that sunk by Messrs. C. J. & A. B. Dupont, in the city of Louisville. This well is three inches in the bore, and two thousand and eighty-six feet deep. The water flows from this well at the rate of three hundred and thirty thousand (330,000) gallons in twenty-four (24) hours, or two hundred and sixty four (264) gallons per minute, with a mechanical force equal to a ten-horse power steam engine. The water rises by its own pressure, when confined in tubes, one hundred and seventy feet above the surface. When the whole force of the water is allowed to expend itself on the central jet, it is projected one hundred feet, settling down to a steady flow of a stream sixty feet high at the above rate of 330,000 gallons in twenty-four (24) hours.

The water is perfectly clear, of a temperature of 76½° Fahrenheit, the year round. It is highly charged with mineral properties, being a strong saline, sulphuretted water, similar in its composition and medical properties, to the celebrated Kissinger waters of Bavaria, and the Blue Licks of Kentucky.

This well was commenced in April, 1857, and completed in sixteen months.

As this mineral water must be, on account of its location, of peculiar interest to all Southerners, I here insert the chemical analysis, as made by Professor J. Lawrence Smith, of Louisville:

	Grains.
Chloride sodium,	621.5204
" calcium,	65.7287
" magnesium,	14.7757
" potassium,	4.2216
" aluminum,	1.2119
" lithium,	0.1012
Sulphate soda,	72:2957
" lime,	29 4342
" magnesia,	77.3382
" alumina,	1.8012
" potash,	3.2248
Bicarbonate soda,	2.7264
" lime,	5.9915
" magnesia,	2.7558

	Grains.
Bicarbonate iron,	0.3518
Phosphate soda,	1.5415
Iodide magnesium,	0.3547
Bromide "	0.4659
Silica,	0.8857
Organic matter,	0.7082
Loss in analysis,	8.1231
	915.5582
Gases in one Gallon.	
Sulphuretted hydrogen,	2.0050
Carbonic acid,	6.1720
Nitrogen,	1.3580

The well bored by Mr. William H. Belcher, of St. Louis, was commenced in 1849, and in 1853 was 1590 feet deep, at which depth a copious stream of "sulphur water issues," which is said to be similar in its properties to the Blue-Lick water of Kentucky.

This well was commenced as a cistern, at the surface of the ground, 14 feet diameter; at 30 feet deep, 6 feet diameter; thence it diminishes to 16 inches diameter, at 78 feet deep. The bore is then 9 inches, and this diameter is continued to 457 feet; thence to the depth of 1509 feet it is 3¼ inches.

At 550 feet, at the top of a limestone, the water became salty; 200 feet below this, in a layer of shale, the water contained 1⅞ per cent of salt. At 965 feet, below a bed of bituminous marl, the water contained 2¼ per cent of salt. The hardest rock was a bed of chert, at a depth of 1179 feet, and 62 feet thick. In this rock the water contained 3 per cent of salt.

This well was commenced in the spring of 1849, and reached its depth of 2199 feet on the 12th of March, 1854. During these five years, the work was at times intermitted for months, so that the time actually employed was only thirty-three months, and cost about $10,000. There is a constant flow of water from this well of 75 gallons per minute.

Three artesian wells have been bored at Columbus, Ohio. The first was carried 110 feet; but, not reaching the rock, was abandoned, the quicksand coming in in such quantities that they could not exclude it by tubing.

The second well was tubed down 54 feet, with cast-iron piping, 6 inches interior diameter. The boring was then continued to the rock 122 feet. Wrought iron pipes of smaller size were forced down, but broke at the second joint from the lower end. The pipe was withdrawn, and a pump let down, when the well was found to be cleared of obstructions to the rock. The reamer was then sent down, and went freely till at the depth of 100 feet it began to rub. The pump was then sent down; the well had become filled with sand and gravel 66 feet, and, after prolonged labor, it

was ascertained that the sand ran into the well as fast as it could be taken out. Various contrivances were resorted to to stop this obstruction, but without effect; so that, on the 4th of November, 1857, this boring was also abandoned. A contract was now made on the 4th of November, with Mr. Fleming Spangler, to bore a new well, with the understanding that he was to tube it into the rock within eighteen or twenty days, or receive no pay.

The new well was commenced by sinking a pit, and cribbing it down with circular cribbing, which, on the 16th of November, reached the depth of 29 feet. After considerable labor, by alternate boring and tubing, Mr. Spangler finally succeeded, on the 31st of January, 1858, in penetrating the limestone rock 248 feet, at a depth of 371 feet from the surface. He then contracted to bore to the depth of 1000 feet from the surface for $1.50 per foot, having thus far averaged about five to six feet in the rock-borings per day.

A vein of sulphur water was struck at 180 feet on the 22d of December, 1857. The borings were continued, with occasional cessation of labor, up to the 11th of December, having then reached a depth of 1858 feet, without, however, up to that date, having reached any considerable body of artesian water; and it is probable, from the details of the borings, that they will have to go from 300 to 500 feet more, through blue limestones, marly shales, and Kentucky River marble-rock, before reaching the porous sandstones, in which there is the best chance of obtaining a body of water.

In the valley of the Ohio, the two great reservoirs of artesian water are the two great porous sandstones, alternating with and resting on the shales which form the impervious layers that hold up the water. One of these great sandstone series constitutes the millstone grit at the base of the coal-measures; the other, the lowest fossiliferous sandstones and calciferous sand-rock, subordinate to the blue limestone and Kentucky River marble-rock of the West.

The water obtained in the first of these reservoirs is, almost invariably, a strong brine; in the latter, so far as experience goes, it is a mineral water, strongly charged with a variety of saline substances, and impregnated with sulphuretted hydrogen gas; hence, though the two first artesian borings, cited above, were eminently successful, as far as obtaining a large body of mineral water was concerned, yet they may be considered entire failures, as far as obtaining a body of pure water fit for manufacturing purposes, or domestic use.

Both these water horizons exist in Arkansas; in fact, the millstone grit, as already stated, has a most extraordinary development in that State; and many localities have been, and will hereafter be recorded, where profitable brines might be obtained in this geological formation, by a judicious selection of locality, and well-conducted, systematic borings.

There are also other water horizons in the southern counties of Arkansas,

which can be reached by borings through the tertiary and cretaceous formations; but, so far as experience goes, artesian waters obtained therefrom will be more or less charged with mineral matter.

As we have some of the records of an artesian well sunk through equivalent formations at Charleston, South Carolina, it may be well in this place to give a few of the statistics of this boring.

Few wells have presented as many difficulties, or called for greater skill and perseverance in the engineer. The surface soil is loose sand for 20 feet, the lower half of which is saturated with water; next, a stiff, compact clay, about 40 feet thick, also water-bearing. At 60 feet, firm marl commences, alternating with some rock more or less indurated, in all 150 feet thick. Below this occur the cretaceous strata, differing but little lithologically from the layers of the tertiary formation above; both formations being alternations of firm marl, sandstone, and loose sands, alternating with layers of hard limestone, seldom containing less than 20 per cent of carbonate of lime. Fifty-four rocks, varying from 2 to 10 feet each, and measuring, in the aggregate, 250 feet, were penetrated by the boring. Cast iron tubes, 6 feet interior diameter, were sunk 80 feet, to exclude superficial sands; but these gradually worked their way down, and continued to flow under the bottom of the tube. Finally, however, the solid rock was reached at 230 feet. But even here the difficulties did not end; for, under each solid rock, quick or loose sand generally occurred, and flowed into the well so as often to fill it up, and sometimes almost instantly, 60 to 100 feet. Large chambers were thus formed under many of the rock strata. Sometimes, in the morning, the well would be found filled 50 to 100 feet, and even 140 feet, with sand. At 700 feet, so much sand continued to flow in as to render it impossible to proceed, and there was no resource but to tube down into it and through it; and to do this, the well had to be reamed out to a larger size, thus taxing the ingenuity of the engineer severely to overcome all the various obstacles to success. At 1020 feet the sands again came in, so as frequently to fill up the well 100 feet; but the difficulty was finally overcome by retubing with larger wrought iron tubes, which were sunk to 1102 feet, and the boring continued 43 feet lower, or 1145 feet.

The temperature, at 900 feet, was $82\frac{1}{2}°$ Fahrenheit.*

* The details of difficulties, instruments used, &c., may be found in the "Mining Magazine," Vol. I, pages 251 to 256.

The same difficulties as those experienced at Charleston need not be anticipated in passing through even the corresponding formations in Arkansas, since, so far as my experience goes in regard to the lithological character of the tertiary and cretaceous rocks of that State, there is but little loose sand in their composition. The principal beds of sand that are likely to be encountered in Arkansas in sinking artesian wells in the recent geological formations of that State, are the gray and orange sand, belonging to the quaternary period, which overlie the tertiary strata. These are usually only from 40 to 90 feet in thickness, and certainly not nearly so mobile in their particles as those described in the Charleston borings.

Subsequent to this date, the Charleston well was sunk to the depth of 1250 feet, and yields 30,000 gallons of water in twenty-four hours, which rises ten feet above the surface. Another has now been commenced at the same place, twelve inches in diameter, and has already reached the depth of 1000 feet.

On the 22d of April, 1857, an Artesian well was commenced at Lafayette, Indiana, and after sinking to the depth of 216 feet, a vein of water finally overflowed the well, on the 18th of February, 1858. The boring was then continued to the depth of 230 feet. Great delay, and an unnecessary cost of $1000 were incurred, in consequence of one of the cast iron pipes breaking, in being forced into its place. This well delivered on the 3d of September, one wine-gallon of mineral water in 15.8 seconds, which is equal to a discharge of 1468 gallons in twenty-four hours; sufficient, if the surplus water be properly saved, for all the purposes of a first class watering-place. This mineral water contains, according to Dr. C. M. Wetherill, 400 grains of solid matter to the gallon. For an analysis of this water, I refer the reader to the Report on this well, made by C. M. Wetherill, Ph. D., M.D.

The well from which the name Artesian was originally derived, was bored more than a century ago at Aire, in Artois, in France, and has flowed steadily ever since. The water rises eleven feet above the ground, and supplies nearly 250 gallons per minute.

The Grenelle well at Paris was commenced in 1834, and completed in 1841, at which time the rod suddenly descended several feet, and shortly after, the water rose to the surface in vast quantities. For the first fifty feet, the boring was twelve inches in diameter; which was reduced to nine inches, and then carried to a depth of 1100 feet; a further reduction was made to seven and a half inches, until the depth of 1300 feet was reached; and a final diminution to six inches, till the termination of the well at 1806 feet. From the completion of the well to the present time, there has been a steady flow of over half a million of gallons in twenty-four hours, of a temperature of 81° Fahrenheit.

The Kissinger well in Bavaria, is 1878 feet; the last 138 feet, the boring passes through rock salt. From this well, 100 cubic feet of water gushes forth every minute. The water contains three and a half per cent. of salt.

The Artesian well at the Bois de Boulogne, is over thirty-nine inches in diameter. This well was bored by a peculiar drill, weighing about 3500 pounds, managed by a grapple, which opens as it descends, and then closes, when it is raised, by means of a parallelogram connected at the angles with two cords reaching up to the top of the well, where they may be managed with the hand, or by means of machinery. The drill below is constructed with seven teeth of cast steel, fitted to drive into the bed of rock, or abrade it. The drill has a shank, by which it may be seized and lifted.

The whole is worked by a twenty-four to thirty horse-power engine. The grapple closes at bottom, seizing the handle of the drill; then rises with the drill several feet, opens, and lets the drill fall. Thus the drill rises and falls twenty or thirty times in a minute. After working twelve hours, the rods are taken out, the sand-pump let down, and the sand and mud withdrawn, and the rods, grapple, and drill again let down, and set to work. To work this apparatus requires only six men, and the cost of working is about three dollars per foot.

In 1857, this well had reached a depth of 1427 feet; and they hoped in October, to reach the main source of water below the chalk.*

In the month of May, 1858, the French engineer, M. Jus, commenced boring an Artesian well in the Sahara Desert, Africa, in the province of Constantine; and, on the 19th of June, a jet of water, of about 1000 gallons per minute, flowed from the bowels of the earth, at a temperature of 61° 24′ Fahrenheit. The joy of the inhabitants was unbounded when they witnessed this extraordinary spectacle, and caused them to regard a people, who could bring about such a marvel as to cause water to gush forth from the arid desert, as truly beings of a superior race.

Subsequently four other wells were bored in the desert; one at Temakin, yielding 8 gallons per minute; one in the oasis of Tamelhat, which gave 120 litres of water per minute; one in the oasis of Sidi-Nached, yielding 4300 litres of water from the depth of 54 metres, the oasis having been completely ruined by drought; one also in Oum-Thior, which yields 108 litres of water per minute; and a sixth well has been sunk at Shegga.

A remarkable Artesian well was bored at Bourne, in England. The borings passed through two strata of limestone, with other intervening strata, to the depth of only 92 feet. The bore is only 4 inches, and this supplies the town through mains and smaller pipes, and plugs for fires, the pressure being sufficient to throw water over the buildings. It delivers 557,000 gallons per day. It rises at the Town Hall 39 feet, 9 inches.

These are a few of the statistics of some of the most interesting Artesian wells, both in this country and Europe; they give some details of the cost, mode of boring, and difficulties to be encountered, that will be interesting and useful to the readers of this Report.

The conditions necessary to a successful boring of an artesian well are:

First. A fountain-head more elevated than the locality where the boring is to be undertaken.

Second. A gentle inclination, or moderate dip, from the fountain-head towards the locality of the well.

Third. Alternations of porous and impervious strata, beneath the drainage of the country.

* Am. Jour. Science, N. S., Vol. XXI, page 404.

The fountain-head need not be in the immediate vicinity; on the contrary, it is often far distant,—forty to a hundred miles or more. If it forms the elevated rim of a large basin, from which the strata dip in all directions towards its centre, it is all the more favorable for Artesian borings within that basin. If the geological formations form a synclinal fold or trough, the fountain-head being on the anticlinals of the ridges more or less parallel, this is also a favorable position for Artesian borings.

The flow of water from the fountain-head, held up by the impervious strata beneath, and permeating the porous, superincumbent layers, may be arrested, however, even without such a structure of the country, by being dammed up by local barriers, which may either be impervious fissures, cutting the strata more or less at right angles, or extensive faults filled up with clay, which is a very common occurrence.

A steep, or high angle of inclination of dip, is always an unfavorable structure of country; because, in such situations, the water flows away beyond the reach of artesian borings, which must necessarily cut the strata at such an acute angle as to pass through only a few layers of rock. Without a knowledge of the internal structure of the geological formations which lie deep-seated, very little clue can be obtained to the selection of a favorable locality, by a simple inspection of the physical condition of the surface of the country. For instance, a perfectly level plain, with no hills in sight, may be more favorable for artesian wells than an undulating country, simply from the fact of its having a higher fountain-head.

The third condition mentioned above, namely, alternation of porous and impervious strata, is almost everywhere to be met with.

For local details in regard to localities of artesian wells in Arkansas, the reader is referred to the sections descriptive of the individual counties.

THE NATURAL STEPS.

CHAPTER IV.

FURTHER REMARKS ON VARIOUS COUNTIES IN ARKANSAS.

SECTION I.

PULASKI COUNTY—CONTINUED.

In May of 1859, a Geological Reconnoissance was made of the "Fourche Cove" country of this county.

From the name "Cove," one would be led to expect to find a confined valley, surrounded, or nearly so, by mountains, somewhat analogous to the Magnet Cove, in Hot Spring County. But, except in the existence of granite and other rocks of igneous origin, there is but little resemblance in the physical features of the two regions.

The so-called "Fourche Cove" is, in fact, a ridge of from two hundred to three hundred and sixty feet in height, ranging northeast and southwest, and sending off a few subordinate spurs; rather flat on the top, expanded at its widest part near the middle of the range to two miles, and diminishing in width both to the northeast and southwest.

On the north, where the small creek that carries off the water from the flat summit, makes its way to empty into Fourche creek, there is a gap or depression. If any part of this granite region is entitled to the name of Cove, it must be this outlet for its waters.

On the east half of the northeast quarter of Section 28, in Township 1, Range 12, is the granite declivity mentioned in the first chapter, as remarkably favorably situated for quarrying for building purposes. This granite is eminently felspathic, the felspar containing both soda and potash, though it has the white color, lustre, and cleavage of Cleavlandite. The quartz is pale gray; a few crystals of hornblende are disseminated, with occasionally small flakes of black mica. This rock might, perhaps, be called a granite-syenite, but the proportion of hornblende and mica is so small that it is better designated as a felspathic granite.

On the southwest quarter of Section 34, Township 1 north, Range 12 west, granite of similar appearance and composition has been quarried for millstones; a pair of which are now in use in Wool's horse-mill. They

can only be regarded, however, as a poor substitute for the true porous silicious burr millstone. On the northeast of Section 33, Township 1 north, Range 12 west, there is a kind of basaltic rock, composed largely of augite, and showing a somewhat porphyritic appearance of the weathered surface.

On the northeast quarter of Section 9, Township 1 south, Range 12 west, some two hundred dollars were expended several years back in search of ore, but without any success. The rock here is a ferruginous amygdaloid of rather a peculiar character. The amygdules are very globular, so that the rock has much the appearance of pea-stone, the cavities being mostly empty. This rock seems to bear northwest and southeast, as it occurs again on the southwest of Section 4, Township 1 south, Range 12 west, where an old digging is visible, made in search of gold. The explorers do not seem, however, to have penetrated more than ten or fifteen feet into the rock. They struck a kind of crevice in the subcolumnar rock, which has a tendency to weather into globular masses. All that seems to have been discovered were crusts of oxide of iron.

On the southwest quarter of Section 9, Township 1 south, Range 12 west, are old Spanish diggings, also made in a variety of amygdaloid rock, but not so well characterized as that on the northeast quarter of the same section.

On the same quarter section, *i. e.*, the northeast of Section 9, Township 1 south, Range 12 west, a white trachyte wacke was observed, which is passing gradually, by disintegration and loss of some of its potash and silica, into a white kaolin or porcelain clay, as is best seen near the site of an old mill, on a small branch close by. In the same vicinity are the remains of an old furnace, in which, by the appearance of the slag, they seem to have attempted to smelt some ore.

On Section 4, Township 1 south, Range 12 west, there occurs also a white argillaceous rock, having the appearance of a disintegrating trachyte. In the vicinity of this rock there is every symptom of a good deposit of porcelain clay.

On the northeast quarter of Section 33, Township 1 north, Range 12 west, the rock is a very ponderous, black, porphyritic basalt, composed chiefly of augite, with large imbedded crystals of jet-black augite. This rock weathers of a rusty black, from the large proportion of oxide of iron present. It has very much the appearance and character of part of the rock of which the great plateau of the ancient volcanic region of the Cantal, in France, is composed, except in the absence of the mineral olivine, which I have not observed as yet, in the Fourche Cove.

On the same quarter section, the basalt is perfectly compact and close-textured, like that around the lake of Nemi, near Rome.

On the southeast quarter of the same section is a gray stone, composed

largely of Labrador felspar, and some augite, which is rather porphyritic on the weathered surface.

On Section 4, considerable search has been made for gold, but without any success, so far as I have been able to learn.

On the southeast quarter of Section 27, close to the section line, is a kind of ferruginous trap associated with a quartzose rock. On the east half of this section, the quartz rock is traversed by veins of milky quartz, here in great abundance, which has induced the mineral-hunters to prosecute their mining prospects in this direction also. The pits which they dug are now filled with water, and there is no indication in the materials of the old rubbish, that any discoveries of importance were made. From its appearance, I should think that they must have penetrated the edge of a slaty rock, which comes here in contact with the quartz rock.

In the region of granite and trap, on Section 34, old diggings are also visible.

On the southeast slope of the granite, on the southwest of Section 34, this rock has more of a porphyritic character, and contains more black mica, and is therefore more porous in its structure. Here is the locality where they have got out some millstones.

It was from the level tract of land on George Pile's farm, just beyond this granite slope, that the samples of granite soils were collected for chemical analyses; growth red, black, and white oak, black and pignut hickory, dogwood, maple. These soils have been analyzed and reported on Nos. 400, 401, 402, and 403 of Dr. Peter's Report. Nos. 400 and 401 are rich, and contain more lime and phosphoric acid than is usually found in purely granite soils. The large proportion of lime may be derived from the augitic hornblendic rocks associated with the granite; and a part of the phosphoric acid, and perhaps a part of the lime, may be traced to the tertiary rocks, which lie at no great distance to the south and southeast; and from which, in part, the subsoil and underclay seem to have been derived, judging from the increased quantity of phosphoric acid found in them.

These soils are said to produce, on an average, thirty bushels of wheat to the acre, and twenty-five bushels of corn. One of the greatest disadvantages of this soil is its disposition to produce a spontaneous growth of persimmon sprouts, which are very difficult to eradicate.

Another variety of soil was collected from the plateau over the dark basaltic rocks; but time has not yet permitted the completion of its chemical analysis. This soil was taken on the northeast of Section 33, Township 1 north, Range 12 west, where the growth is red and black oak, sweet-gum, large dogwood, black hickory, and some ash and elm.

There are several important localities of limonite iron ore in Pulaski County. One of the most important is in Section 11, Township 1 south, Range 12 west. This is, perhaps, one of the best prospects of iron ore

associated with sandstone which I have seen. It is true that some of the ore immediately in connection with this rock is rather too silicious; but still there are large bodies of good iron ore fit for smelting in the high furnace, especially on the ridge north of Ellis's mill; that is, in the northeast part of said section, and in the southwest corner of Section 2. Also on the ridge south of the schoolhouse, viz., on the north part of the southwest quarter of Section 11. On these ridges almost every tree blown over by the wind shows ore entangled in its roots, and in some places the ground may be said to be literally strewed with ore.

The following chemical analysis, made from a sample taken from the northeast quarter of Section 11, Township 1 south, Range 12 west, being a variety commonly known among smelters by the name of "pot ore," will show the composition of one variety of these limonites:

Moisture,	10.200
Insoluble silicates,	9.250
Peroxide of iron,	78.150=54.70 iron.
Alumina,	1.600
Lime,	0.100
Magnesia,	0.060
Alkalies,	0.600
Sulphuric acid,	0.030
Phosphoric acid,	Trace.
Loss,	0.010
	100.000

Another concretionary variety of ironstone yielded, by analysis, the following result:

Moisture, expelled at 400° F.,	11.50
Insoluble silicates,	23.20
Peroxide of iron,	63.80=44.80 iron.
Alumina,	00.35
Lime,	00.05
Magnesia,	00.16
Alkalies,	00.50
Sulphuric acid,	00.06
Phosphoric acid,	00.31
Loss,	00.07
	100.00

Another fine locality of iron ore is near Fourche creek, one mile south of Dr. Halliburton's old stand, Section 18, Township 1 south, Range 13 west. Near the line between Sections 19 and 20, there is probably a body of fine ore. On these sections, large blocks of fine pisolite iron ore are

frequently met with on the surface, more than a man can lift. A specimen of this ore yielded by analysis:

Moisture, expelled at 400° F.,	6.60
Peroxide of iron,	67.47=47.39 iron.
Alumina,	15.30
Lime,	00.20
Magnesia,	00.18
Alkalies,	00.40
Sulphuric acid,	00.01
Phosphoric acid,	00.14
Insoluble silicates,	9.65
Loss,	00.02
	100.00

There is also a fine body of iron ore on the heads of Lost creek, on the southwest corner of Township 2, Range 14 west, in the vicinity of William Thomson's.

These ores are either of quaternary or tertiary date.

These localities of iron ore are well worthy the attention of the iron-master, more especially as the country is well timbered.

Tertiary limestones and marls show themselves in several places in Pulaski County, viz., on the western outskirts of Little Rock, near the Penitentiary. Limestone has likewise been struck in some of the wells in the same vicinity; also two and a half miles from Little Rock, near the line between Sections 8 and 9, Township 1 north, Range 12 west of 5th P. M.; also on the northeast quarter of Section 18, Township 1 south, Range 13 west, on the banks of Crooked creek; also on the line between the northeast and southeast quarters of Section 8, Township 1 south, Range 13 west, on Fourche creek, near the mouth of Crooked creek, where it forms a low cliff of compact tertiary limestone, about eighteen feet exposed. From the quality of the limestone at this locality, it would make better lime than any other exposure I have seen in Pulaski County.

In the slope above there is, probably, a bed of marl; but at present it is covered with vegetation.

It is probable that the area of these tertiary calcareous rocks was formerly much more extensive than it now is in Pulaski County, as I believe it has suffered greatly from denudation during the movements which took place since its deposition, in the period when the local superficial drift of the county was accumulated, which conceals, to a great extent, both the tertiary beds and the slates.

Immediately northwest of Little Rock, there is a fine exposure of contorted slate, which has very much the appearance of roofing slate; so much so, that a company was formed to quarry slates for that purpose at this

locality, and several houses in Little Rock were covered with it, by way of experiment. Experience proved that it was incapable of standing atmospheric vicissitudes, and winter frosts; since there is too much alumina in its composition, and the rock is not sufficiently indurated.

Westward from Little Rock the slate becomes more magnesian and lighter colored, as may be seen at Dr. Halliburton's old stand, where this formation is much fractured and ramified with veins of milk-white quartz, which usually have a bearing a few degrees south of west and north of east.

This formation is also traversed locally, by beds of whinstone, as at the Big Rock, on the Arkansas River, where it is employed extensively for building purposes.

On the northwest quarter of Section 21, Township 1 north, Range 13 west, on Lightfoot or Brodie's Creek, there is a very hard quartzose slate, associated with slate which approaches roofing slate, dipping at an angle of about 45°, north 10° to 20° west. It is possible that a better quality of roofing slate might be found there than on the Arkansas River above Little Rock, as it is less argillaceous and more indurated.

Dr. Halliburton's well-water was tested qualitatively, and found to contain as its principal ingredients:

Chloride of Sodium,
Chloride of Magnesia,
Bicarbonate of Lime—small quantity,
Bicarbonate of Magnesia—small quantity,
Bicarbonate of Soda.

The waters of the Fourche were also tested, and were found to contain the same ingredients, with a trace of oxide of iron. The principal difference between the water of this creek and Dr. Halliburton's well-water is, that the former contains less lime and more magnesia, less chlorides, less carbonate of soda, and more iron.

Soils were collected for chemical analysis from the slate region of this vicinity, where the growth is principally sweet-gum, ash, elm, black hickory, linn, hackberry, ironwood, with an undergrowth of spicewood and small buckeye. These soils have been analyzed, and will be found recorded in Dr. Peter's Report, Nos. 397, 398, 399. They show very clearly their origin in the large proportion of magnesia contained, especially in the subsoil lying closest to the magnesian strata.

Slate and quartz are the prevailing rocks on Fourche Creek, north of Halliburton's. In the adjacent hills quartz predominates, where the growth is small pine, post-oak, and pignut hickory. Approaching the Little Maumelle, the slate assumes more the character of roofing slate. It is possible some good quarries might be opened in this vicinity.

Near the west side of Township 1 north, Range 15 west, on J. P. Will's farm, on Caney Creek, blue and gray limestones occur.

Tolerable samples of novaculite (oilstone), were observed on the east side of Township 2 north; also on Section 7, Township 1 north, Range 14 west, one mile south of Thomas Fletcher's. Some iron ore occurs near Howell's tanyard, on Section 36, Township 2 north, Range 14 west; also on Section 4, Township 1 north, Range 14 west, according to the representations of the County Surveyor, Thomas Fletcher. He reports likewise a chalybeate spring on Township 2 north, Range 15 west. At this gentleman's residence, the slate dips north 10° east, at an angle of 47°. It is black, fibrous, and brittle, and rings under the hammer. It passes, locally into a jet-black rock, resembling petrosilicious slate. Another variety, is a light cream-colored silicious slate, some of which will answer for oilstone, as it is fine-grained, and of the proper degree of hardness. This rock occurs on Section 7 or 8, Township 2 north, Range 14 west.

On the Little Maumelle several hundred feet of dark slate are exposed, dipping at an angle of 48°, bearing nearly east and west, associated with a bed or beds of quartz, having the same bearing.

One of the highest points in Pulaski County is the high conical peak, known as "The Pinnacle." By measurement by the aneroid barometer, it was found to be seven hundred and seventy feet above the Arkansas River. The summit of this Pinnacle is of hard sandstone, of the millstone grit formation, dipping north at an angle of 22°. Some of it is a most beautiful white gritstone, well adapted for building purposes. It is only the loose blocks which have rolled down the mountain, which are at present accessible. By good engineering, however, a road could be carried up on the north slope. In sight of the Pinnacle, on the Arkansas River, near the mouth of the Big Maumelle, are "The Natural Steps," already mentioned in the first chapter, and represented by the woodcut at the head of this Section.

These are formed by two prominent walls of hard sandstone, which are nearly standing on edge, having between them about twenty feet of reddish, contorted, and fractured argillaceous shales, with segregations of iron ore, the southeast wall being flanked on the southeast by a similar mass of shale, at least a hundred feet exposed. These masses of shale have crumbled away and formed steep, smooth banks, from which "the Natural Steps" jut forth in bold relief. The height of "the Natural Steps" I found to be forty feet above the Arkansas, at its stage when I examined and sketched them, on May 30th, 1859, but they are fifty-one feet above low-water mark.

Seen from the river at a little distance, they have a wonderfully artificial appearance, looking like steps laid by regular masonry, and form, indeed, not only a remarkable feature in the landscape, but also a striking and unequivocal instance, of which Arkansas furnishes several, of strata tilted nearly on edge.

SECTION II.

PERRY AND YELL COUNTIES.

These are mountainous counties; the principal ranges being the Fourche la Fave Mountains on the south, and the Petite Jean on the north. These ranges are composed almost entirely of the shales and sandstones of the millstone grit: the shales predominating towards the base, the sandstones towards the summit; and one of the principal beds of sandstone often appears as a prominent escarpment, running like a battlement along the brow of the mountain. Towards the base is a thin bed of coal, from six to twelve inches thick, and seldom, if ever, exceeding fifteen inches; and therefore it may be considered of little practical value, only occasionally supplying the country blacksmith with a few bushels of indifferent coal.

This coal shows itself near the termination of the Petite Jean range, on Coal-bank branch of Shut-in creek, one of the branches of the Petite Jean creek, near the Gravelly-branch, supposed to be on Section 29, Township 5, Range 18 west. The coal is here covered with dark-gray argillaceous shales, with disseminated argillaceous iron ore, and is twelve to fifteen inches thick. Back of Howell's farm, the same coal shows itself in a great bank of variegated red and gray shales, with disseminated iron ore, the whole overlaid by sandstone dipping at an angle of 15°, north 20° west. The shales appear to be of great thickness, at least 150 or 200 feet, at the base of the mountain. Along the bank of the creek there are several extensive licks, indicative of salt.

There is a remarkably deep ravine commencing near the outcrop of the coal, and bearing up the mountain to the northwest. This appears to be partly due to the extensive denudation of the soft shale, and in part to the dip of the strata; and is not due, as has been supposed, to any violent eruption just at this locality. The outcrop of coal near Lewis Moulder's house, on Section 35, Township 6 north, Range 21 west, has some fossil plants in the roof-shales, belonging both to the family of calamites and ferns; but the coal-openings being filled with water, both the shales and the coal were difficult of access.

All these coals enumerated belong, in all probability, to the same horizon as the coal described in the first volume, at the base of the Carrion Crow Mountain.

An approximate chemical analysis has been made of four of these coals, as follows:

PLATE B.

Lith. by A. Hoen & Co. Baltimore.

SHORT MOUNTAIN FROM THE HAGUEWOOD PRAIRIE SANDSTONES, SHALES AND THIN COAL OF THE MILLSTONE GRIT.

Specimen of Coal from the Gravelly branch of Rocky Cypress, foot of Petite Jean Mountain, one and a half to two miles northwest of John Ward's, on Section 29, Township 5, Range 18, Perry County, Arkansas.

Volatile matter,	28.5	Water,	11.5
		Gas,	17.0
Coke,	71.5	Fixed carbon,	66.5
		Ashes (red),	5.0
			100.0

Coal from L. E. Moulder's, "Moulder's Prairie Coal" Branch, Yell County, Arkansas.

Volatile matter,	11.14	Water,	3.0
		Gas,	8.4
Coke,	88.6	Fixed carbon,	78.6
		Ashes (dark red),	10.0
			100.0

Analysis of J. A. Daker's and B. Howell's Coal, Section 32, Township 6 south, Range 21, eighteen to twenty-two inches thick, Yell County, Arkansas.

Volatile matter,	14.40	Water,	3.0
		Gas,	11.4
Coke,	85.60	Fixed carbon,	80.4
		Ashes (dark grayish-red),	5.2
			100.0

Coal from base of Petite Jean Mountain, at Howell's farm, Perry County, Arkansas.

Volatile matter,	26.20	Water,	9.0
		Gas,	17 2
Coke,	73.80	Fixed carbon,	71.8
		Ashes,	2.0
			100.0

This coal retains its original shape in coking. The specimen analyzed was taken from a natural outcrop of coal at the foot of the mountain.

At the first hill beyond the Big Maumelle, the sandstone of the millstone grit was observed dipping at an angle of 30°, north 20° west. This rock splits out in cuboidal blocks having a rusty surface, and warm-gray color internally. This is the general character of the main rock in this vicinity, with some shaly and flaggy intercalations. Many of the blocks have a dark ferruginous band encasing a light-gray interior.

The summit level on the main ridge passed over on the Perryville road, is upwards of five hundred feet above the Maumelle river.

The summits of these higher ridges have a fine growth of pine timber, both in Pulaski and Perry counties.

On the northwest side of the Ten-mile Ridge the sandstone was found dipping at an angle of 35°, north 30° west.

At the town of Perryville, I found the well-water, at thirty feet deep, strongly impregnated with common salt and some sulphates. This is one of the strongest saline waters that I have met with in water used habitually for domestic purposes. There are little or no carbonates of the alkaline earths. This vicinity would be a favorable situation to bore in search of good brine.

The ridge of sandstone passed over after leaving Perryville, is about three hundred feet above the Fourche la Fave, and the waters of Cypress.

On the divide between the Fourche la Fave and Cypress, the sandstone bears more to the south of west, than it does on the south side, near the Fourche la Fave.

Soils were collected for chemical analysis from Joseph Ervin's plantation, from bottom-land at the foot of the Petite Jean Mountain, where the growth is white, black, and red oak, walnut, sweet-gum, with an undergrowth of hickory grubs, and grapevines. Soils were also collected from the table-land on the Petite Jean Mountain, at James Morris's, overlying sandstone of the millstone grit; growth, pine, oak, and hickory.

The Ervin soils have been analyzed, and recorded in Dr. Peter's Report, Nos. 385, 386, 387, and their composition shows them to be of fair average fertility.

A set of soils were also collected from near the foot of the Petite Jean Mountain, where it forms a headland on the Arkansas River, from W. C. Stout's farm. There is rather more sand in the composition of this soil, than in the Ervin soil, as is very generally the case, near the Arkansas River. These soils have also been analyzed, and recorded in Dr. Peter's Report, Nos. 388, 389, 390.

The height of the Petit Jean Mountain was measured at the Gap, above Joseph T. Ervin's house, and found to be four hundred and sixty-five feet. There are two terraces of sandstone towards the top; the upper crowning the brow of the mountain. The following is an approximate section; the numbers showing their elevation above the Ervin farm:

465	feet	top of the Gap, on sandstone.
385	"	cellular sandstone.
325	"	upper red shales.
285	"	flaggy sandstone.
255	"	middle red shales with sandstone beneath.
220	"	lower red shales.
185	"	bottom of the last exposure.
0	"	bottom land of Ervin farm.

In the intermediate spaces no rocks are visible; but they are undoubtedly filled with crumbled shales, which form the great mass of the mountain. In a branch, at the foot of Mr. Ervin's plantation, thin coal has

been seen, no doubt the equivalent of the bed already spoken of as nearly coextensive with the Petite Jean Mountains.

Rose Creek splits the Petite Jean Mountains into two prongs: one on the northeast, and the other on the southwest of the creek. This mountain range is incorrectly laid down on the map; since it extends twelve to fifteen miles east of Petite Jean Creek, which is at least ten miles further east than on the map. Its entire length is twenty to twenty-five miles.

It is evident that much of the red, Arkansas bottom lands of Perry County, derives its material from the debris and disintegration of the ferruginous shales and sandstones which form the mass of the Petite Jean Mountains.

Both gold and copper mines are reported by the early settlers near the heads of Rose creek; but the geological structure of these mountains give no encouragement to a belief in these reports.

On the Arkansas River, near the mouth of Cypress creek, limestone is said to occur; but being under water at the time of my examinations in this neighborhood, I had no opportunity of seeing it.

On the road from Howell's to Danville, and about five miles from the former, alternations of sandstones and shales are tilted nearly on edge, the strike line being nearly east and west. The angle of dip measured at one place, was found to be 53° north, at another place 75° south.

On a branch of Petite Jean creek, a quarter of a mile from the Yell County line, five thin bands of limonite ore are visible in the shale, which is very much twisted and contorted, and possesses in many places a splintery, pencil fracture.

There are many other localities along the base of this mountain where more or less iron ore is visible; and if limestone could be found convenient, these localities might be worthy the attention of the iron-master.

The Petite Jean range gradually declines to the westward, until it loses itself as a conspicuous landmark near the confines of Perry and Yell, and a gradual improvement is visible in the soil of the country.

On the ridge near Sloan's, ferruginous sandstone of the millstone grit, is seen dipping at an angle of 38° north; while at the ferry, on Petite Jean river, the dip is only 14°, east 10° north. After crossing the river, the sandstone is seen in a bench rising rapidly to the northeast. For three quarters of a mile the road passed over a post-oak flat, where several licks are visible, indicative of salt.

A qualitative examination was made of the waters of the Dardanelle Springs, which showed them to be alkaline, saline, sulphuretted waters, containing as their principal constituents:

Bicarbonate of soda.
Bicarbonate of lime.
Bicarbonate of magnesia.
Chloride of sodium.
Only a trace of sulphates.
A small quantity of free sulphuretted hydrogen.
Probably a trace of sulphuret of alkali.

The northwest spring contains some oxide of iron.

Mr. E. T. Cox measured the height of the Magazine mountain, in Yell County, above the McCray farm, and found it to be 1405 feet.

The following outcrops were observed in the mountain:

1405 feet. Massive sandstone, upper part in beds from 8 to 10 feet in thickness, and the lower part thin-bedded.	
Shales,	380 feet.
Place of the chalybeate spring.	
Reddish weathering shales,	60 "
Irregularly bedded, micaceous, gray schistose sandstone and silicious shales,	220 "
Micaceous, dark, argillaceous shales,	150 "
Variegated shales, with nodules of clay ironstone,	70 "
Shale and coal,	1 foot.
Blue, argillaceous shale, alternating with dark, silicious shales, with fucoidal markings, with occasional bands of thin sandstone, extending down to the McCray farm,	524 feet.

The McCray farm was found, by subsequent observation, on the 6th of June, 1859, to be about five feet above high water mark of the Arkansas river.

In Section 32, Township 6 north, Range 21 west, a coal has been opened for the use of the blacksmiths of the neighborhood, its thickness varying from eighteen to twenty-two inches.

The following section was obtained at the coal opening:

Ferruginous shales, with nodules of clay ironstone,	5 feet.
Black roof shale, containing fossil plants,	1 foot.
Coal,	1 foot 10 in.
Stigmaria clay in the bed of the creek.	

This coal has a bluish color and submetallic lustre, and seems to be tolerably free from sulphur, from the accounts given of it by the blacksmiths.

The summit level, where we passed over the Fourche la Fave mountain, going to Danville by the old Hot Spring road, was found to be 800 feet above the Arkansas river; but there are adjacent eminences that are considerably higher. On descending to the Petite Jean river, near Danville, the sandstone was found dipping at an angle of about 45°, east 25° south. This rock is disposed to cleave into prismatic blocks, a structure which is found to prevail at several localities on the mountain. There is evidently a change in the direction of the dip and strike line in the Fourche la Fave range, the dip being more easterly than in the Magazine mountain.

Red, ferruginous shales, are equally prevalent in the lower part of the Fourche la Fave range, as in the Petite Jean and Magazine mountains,

and contain also segregations of iron ore. There is great disturbance and irregularity of dip in this mountain,—there being one, if not more than one anticlinal axis. The sandstone is generally very highly inclined, and is often of a character to afford good freestone for building purposes.

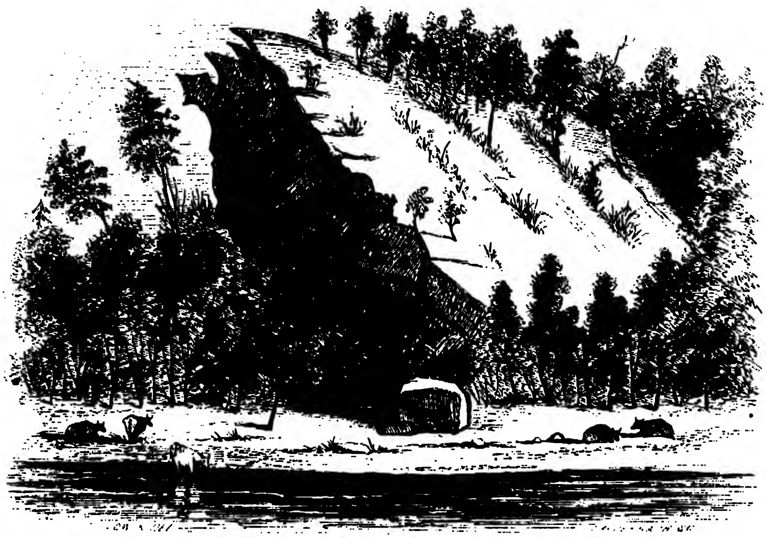
On Section 28 or 29, Township 5, Range 21 west, is a remarkable chalybeate spring, at an elevation of three hundred and seventy feet above Danville, and distant about two and a half miles from that place. From the large quantity of carbonate of the protoxyd of iron present, it has a most powerful deoxidizing effect, instantly blackening nitrate of silver without even the addition of ammonia. Its temperature was found to be 62°, the temperature of the air being 79°, Fahrenheit. It is a saline chalybeate, containing as its principal ingredients:

Bicarbonate of the protoxyd of iron,
Bicarbonate of lime,
Bicarbonate of magnesia,
Sulphate soda,
Chloride of sodium ?

This mineral water not only blackens nitrate of silver, but also chloride of gold, and tincture of campeche.

On Spring creek, cliffs of schistoze sandstone are exposed, dipping to the northwest at an angle of 6° to 8°. Some of this sandstone has a cellular structure, and contains a short-jointed calamite. Higher up on the ridge the angle of dip is increased to 20°; but again subsides after crossing Spring creek. The angle of dip is also moderate on Shoal creek, about twelve miles from Danville.

At the Narrows of Little Shoal creek, the road runs over a very steep hill of three hundred feet in height; so that it is only with the greatest difficulty that a wagon can be got over it. It is composed, as usual, of shale overlaid by sandstone, dipping a few degrees west. After passing this ridge, and a low gap of the Magazine Mountain, leaving the head of Spring creek, we passed over to the waters of Shoal creek, the summit level being three hundred and fifty feet. The prevailing rock seen, is a prismatic flagstone. Soon after this, on reaching the military road, we entered a prairie with a low ridge in the west. This prairie is based upon a dark, gray, brittle shale. On the Arkansas River, at the mouth of Shoal creek, there is said to be a bed of coal, the thickness of which could not be determined.



DARDANELLE ROCK.

SECTION III.

THE CORNER OF POPE COUNTY, SOUTH OF THE ARKANSAS RIVER.

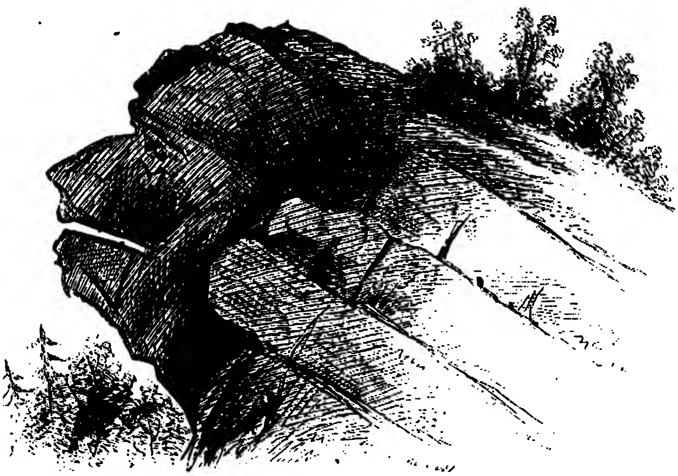
The Magazine Mountain, which will be mentioned more particularly in the next section, forms a most remarkable headland where it terminates on the Arkansas River, opposite Norristown. This is known as the "Dardanelle Rock," represented by the woodcut at the head of this section, taken from the opposite side of the river. This rock is composed of ferruginous sandstone, dipping at an angle of 40° towards the river. The bearing of the comb of the ridge, which is coincident with the strike-line of the strata, is west 10° north. Layers on the summit are of a pale red color, tinged by oxide of iron. On the north slope, the rock is laid off with numerous concentric hard ferruginous veins, disposed in rows of rectangular and triangular figures, with great regularity, giving to the surface a tessellated appearance.

The elevation of the Dardanelle Rock, above the road which winds round its base, is two hundred and fifty feet, and about two hundred and eighty feet above the Arkansas River.

At an elevation of from eighty to one hundred feet, above the base of the ridge, and half a mile northwest of the point of the Dardanelle Rock, a strong chalybeate spring issues from the crevices of the ferruginous sandstone.

From the summit of the Dardanelle rock there is an extensive prospect. The Magazine Mountain is in full view, bearing away to the west-southwest, the Petit Jean to the south, over and beyond which some of the highest peaks of the Fourche la Fave range are visible in the far distance bearing a few degrees east of south, the Arkansas River washing its base on the north, with Norristown on the opposite shore, and level farming lands seen behind in perspective; the Arkansas River, like a bright line, winding its way among them, and conducting the eye to the site of Dardanelle village, partially hid by the forest.

From a single point on the Arkansas River the outline of the Dardanelle Rock on the southeast exhibits a distinct profile, to be remarked by any one on attentive observation, who may be ascending the river, as shown by the woodcut at the close of this section, all the features of the face, and the outline of the head being represented.



DARDANELLE PROFILE.

SECTION IV.

SCOTT COUNTY, AND PARTS OF FRANKLIN AND JOHNSON COUNTIES, SOUTH OF THE ARKANSAS.

The small prairies which commence in Yell County become more extensive and important in these counties. These prairies are, in all cases, based on impervious clays, derived from the disintegration of the shales of the millstone grit. In these counties the high isolated peaks and detached

spurs of mountains, standing out as conspicuous landmarks in the level prairie, give evidence of the extensive denudation which has separated them from the parent range.

Most of the coal which has been found in these counties lies beneath the shale of the prairies, reaching often within a few feet of the surface. Some of the most important outcrops I shall here enumerate.

The Ewing coal-bank, on the mountain branch of Cave creek, four miles east of south of Morrison's bluff, on the Arkansas river, lies in the bed of the branch, and was completely under water when I visited the locality. It can only be mined when the creek is dry, by stripping two feet of overlying soil and black shale. The coal is only eleven inches thick, and lies in a bed of black shale, so that the quantity of coal obtained by working is altogether disproportioned to the labor and expense of obtaining it. Those who have undertaken to mine it hope that it will increase in thickness, but it is not likely to do so within a reasonable distance, as roof shales are already visible. Still it is possible that the bed may be divided into two members by a clay parting, and that the lower member has not yet been exposed. The coal dips slightly down the creek to the north.

The Craven bank is two miles east of the Ewing bank, and three quarters of a mile from James Craven's house. This coal is a semi-bituminous coal, very much resembling the Spadra coal. No roof shale can be seen over the coal, but in the well at James Craven's house there are black shales and "gray metal" resembling the roof of the Spadra coal. The thickness of the Craven bank cannot be well seen; it must, however, be at least thirteen inches thick, judging from the size of the blocks which have been brought out, and perhaps it might be found two or three feet in thickness if fairly entered, with a solid shale roof.

The following is the approximate analysis of the Craven coal in Johnson County:

Volatile matter,	9.75	Water,	2.00
		Gas,	7.75
Coke,	90.25	Fixed carbon,	88.75
		Ashes (grayish-white),	1.50
			100.00

Coke hard and retaining its original shape. This is a semi-bituminous coal, remarkably rich in fixed carbon. It is rather brittle, and easily fractured, but would be more solid under a better covering. It dips to the north, or a little east of north. If mined free from sulphuret of iron, it is coal well adapted for almost any purpose, and very durable in the fire. There are fragments of good limonite ore strewed in the bed of the creek at a lick near by.

Between Sadler's and the Craven bank there is a considerable ridge

capped with sandstone, some of which is flaggy. As this ridge is south of the coal-bank, and the dip is to the north, this may be the equivalent of the flaggy sandstone which underlies the Spadra coal.

Near Lowe's, on the military road running parallel with the Rich mountain, black shale and imperfect coal, or coal-rash, are to be seen. It is not improbable that a bed of coal might be struck here by sinking a pit or shaft.

At Eli Ragan's, coal appears in the bed of a branch below his field; but no attempt has been made to open it.

The Robinson coal is situated on the Short mountain branch, near the edge of the Haguewood prairie. It lies from three to five feet below the surface of this prairie, covered by rusty-gray argillaceous shales, with nodules of clay ironstone. At the north end of the stripping the coal measures eighteen inches; at the south side the miners call it two feet, but here it is partly concealed by water. In some places the stripping is four to six feet through yellow clay in the above-mentioned shales. The miners receive three and a half cents per bushel for raising it, and it sells for twelve and a half cents per bushel at the bank on the Arkansas river; it sells for forty cents by the single bushel, and thirty-five cents by the boat-load.

It is a bright, fibro-lamellar, brittle coal, and preferred by the blacksmiths to most of the coal in this part of Johnson County.

The following is a section of this coal bed:

	Feet.	Inches.
Yellow ochrey clay,	2	
Gray argillaceous shale,	3	
Ironstone,		2
Shale parting,		2
Ironstone,		2
Fire-clay,	1 to 2	
Coal-rash,		2
Coal,	18 in. to 2	
Dark gray and ferruginous clay.		

From Haguewood prairie there is a fine view of the Short mountain, as shown by Plate B.

At the ford on the Short mountain creek, near the base of the Short mountain, in Franklin County, there are several fine beds of carbonate of iron, interstratified with shale, as exhibited in the following section:

	Feet.	Inches.
Ochrey clay,		
Shale,	3	
Dark-gray shale,	1	
Carbonate of iron,		from 1 to 2

	Feet.	Inches.
Shale,		1
Carbonate of iron,		1
Shale,		6
Carbonate of iron,		1
Shale,	2	
Carbonate of iron,	from 1 to 2	
Shale,		6
Carbonate of iron,		1
Shale.		

This, together with similar beds to be found at the base of the Short Mountain, might afford sufficient ore to supply a furnace. The dip of the strata is about 2° southwest.

By estimation, the mountain must be about five hundred feet high. It is capped with sandstone, but the principal mass of the mountain is composed of shales, similar to those in the Petit Jean range.

One mile east of Ozark road, close to Hurricane creek, the blacksmiths have opened a coal-bank, which they report two feet thick, and at Lee's, on the Grand Prairie, some coal has also been found.

From one to two miles northwest of the Main Short Mountain is Little Short Mountain, which presents towards its top two benches of sandstone, with about fifty feet of soft schistose sandstone intervening.

A considerable area of the Grand prairie, in the vicinity of Judge Aldridge's, is underlaid by coal. On Section 28, Township 8, Range 28 west, I found the coal in the bed of a branch running through that prairie, resting on a brown stigmaria clay, and covered by brown shale two feet, over which is ferruginous gravel and clay from one to two feet thick.

At Stony point, on Section 25, Township 8, Range 29 west, a fine even-bedded sandstone crops out from an elevated position, forming a rocky eminence in the midst of the Grand prairie, where fine building-stones of almost any dimensions might be obtained. This rock has a slight easterly dip, and undoubtedly runs under the coal in the prairie. When newly quarried this stone works free under the chisel and hardens by exposure. From Stony Point there is a most extensive prospect in all directions over the Grand prairie, and far in the distance to the east can be seen looming up the western extremity of the Magazine Mountain, as represented in the lithographic view, plate C, flanked on the north by subordinate hills in distant perspective.

The dip of the Grand prairie in Franklin county is irregular. About half a mile east of Stony Point there are two anticlinals, or axes of dislocation, crossing each other at right angles, one running nearly east and west; the other, north and south. This irregularity in the dip brings the harder rocks occasionally to the surface, and at the same time cuts out the coal. The elevated ridges in the prairie are formed in this way.

D.D. Owen del.

MAGAZINE MOUNTAIN FROM STONE POINT IN THE GRAND PRAIRIE OF FRANKLIN COUNTY
SAND-STONES, SHALES & THIN COAL OF THE MILLSTONE GRIT.

Soils have been collected for analyses in the Grand prairie, but the analyses are not, as yet, completed.

In passing from the Grand prairie south into Scott county, towards Boonville, four to five anticlinals are passed over, with intervening synclinal valleys; the latter are usually parallel prairies; the former wooded ridges. One of the anticlinals is near Boonville, between Petit Jean and King's creek; one at the foot of a high ridge, where the dip is very suddenly reversed to the south, and is continued into the next low ridge beyond; one in the Narrows of Six Mile creek, near Chisholme's, where the north dip is well marked in the sandstone in sight of the old Chisholme house; one in Oak Ridge, before descending to the next creek, where the south dip is again seen; and one a mile south of the edge of the Grand prairie.

Then on the south side of Petit Jean, the north dip is well marked in the sandstone on Cook's farm. Thus, there are at least five great waves or breaks in the strata, accompanied with reversals of dip, between the Grand prairie and Sugar creek valley, showing how much the country has been convulsed since the deposition of the millstone grit, that formation as well as the coal being implicated in the disturbance.

The strata here, as in the preceding counties, consist of shales which are frequently red and ferruginous, alternating with sandstones.

Coal is not as abundant, so far as I have yet seen, in Scott as in Franklin. It is found, however, on the coal branch of King's creek, dipping to the east. Though only a few inches thick where first entered, it increases to a foot by following it along the dip. It is covered by a considerable thickness of gray and variegated shales, over which are black shales.

Considerable masses of ferruginous conglomerate are strewed in the bed of the creek, which seem to originate from partial segregations of this rock amongst the shale. The succession below the coal seems to be as follows:

Shale,	Shale,	Shale and shaly sandstone,
Coal,	Building stone,	Second sandstone.

A chalybeate spring issues from this last rock, where it rises from beneath the bed of the creek.

At the steep, rocky ridge, four miles west of Petit Jean, the sandstone at the top dips at an angle of 12°, south 10° to 20° west, the same as at the stone-quarry on Coal Branch creek; only, there, the dip is east of south instead of west of south.

The succession in this ridge is:

	Feet.	Inch.
Flaggy sandstones in beds of from two to nine inches in thickness,	15	00
Ferruginous, sandy, and variegated shales, interstratified with bands of sandstone,	100	00
Soft shales decomposing into a red clay, also with some bands of sandstone, forming the principal mass of the base of the hill, and passing downwards into soft, ferruginous shaly sandstone,	200	00

If there is a continuous southerly dip from the synclinal of Petit Jean river, these shales and sandstones must underlie the coal in the coal branch of King's creek.

There is another coal in Six-mile creek, and also on Big creek.

Between Waldron and Caleb Baker's, the strata are very much disturbed, frequently turned almost on edge; and, judging from the extensive surface passed over on the edges of highly inclined strata, the shales and sandstones of the Millstone Grit must have been of enormous thickness.

At Caleb Baker's, in Section 35, Township 2, Range 29 west, there is the largest body of limestone in this part of Arkansas.

At the southwest corner of Section 36, Township 2, Range 29 west, the limestone is of a dark-gray color, associated with black flints, as in Wiley's cove. Most of the limestone has a brecciated character, and the angle of dip is sometimes as high as from 50° to 80°. Veins of calc spar are not unfrequently met with, which have induced some of the early settlers to dig for ore. Some of the beds of this limestone produce, when properly burnt, a very fine white lime, viz., the fine-textured gray rock. The general dip of the limestone is a little west of south.

Two miles south of west from Caleb Baker's, on the main Fourche la Fave, heavy beds of limestone are seen at intervals for four miles.

On Mill creek, there is abundance of white and yellow iron pyrites, which attracted much attention among the first settlers.

This limestone undoubtedly marks the limits of the coal south in Scott County.

This is one of the few examples of Subcarboniferous Limestone exposed on the surface south of the Arkansas river, and must always be an important locality in a country where limestone is so scarce.

A set of post-oak soils was collected one mile from Waldron, from Section 17, Township 3, Range 21 west, based on dark gray shales, with some calc spar disseminated.

This soil has been analyzed, and will be found recorded in Dr. Peter's Report, Nos. 360, 361, 362.

Another set of soils was collected in Scott County, from the bottom lands of the Poteau river, on Section 15, Township 3, Range 13 west, on Dr. Smith's farm, where the growth is sweet-gum, elder, maple, blackberry, black-oak, and box-elder, with an undergrowth of spice and pawpaw.

These soils have also been analyzed and recorded in Dr. Peter's Report, Nos. 345, 346, 347.

About 275 feet below the top of the Chalybeate Hill, a strong chalybeate water issues from the ferruginous sandstones in the southern slope of that hill, and considerable iron ore is strewed along the hillside. This water is a saline chalybeate, possessing strong deoxidizing powers. It is situated near the line between Sections 16 and 21, Township 3, North Range 30

D. D. Owen del.

Lith by A. Hoen & Co. Baltimore

CORTES MOUNTAIN FROM HODGES PRAIRIE, EASTERN TERMINATION OF THE SUGAR-LOAF RANGE,
SEBASTIAN COUNTY.

west, probably towards the southwest corner of 16. This would be a most valuable mineral water for invalids requiring a pure tonic with a slight alterative influence combined.

The spring water rising from the shales of the millstone grit, in the Poteau valley, at Dr. James H. Smith's, was also tested qualitatively, and found to contain principally chloride of sodium, a trace of bicarbonate of lime, and a trace of bicarbonate of magnesia.

The west branch of the Poteau river was also tested, and found to contain less chlorides, and more carbonates of the alkaline earths.

SECTION V.

SEBASTIAN COUNTY.

The prairie regions are more extensive in this county than in any other in the State.

The coal is also thicker and more extensive than in any other part of Arkansas.

Almost every synclinal, from the Arkansas river to the Poteau range, brings in the shale and underlying coal, producing at the same time that retentive and impervious clay soil peculiar to the prairies of Western Arkansas.

Commencing in the northern part of the county, we find coal on the Garrison prairie, cropping out in the southwest quarter of Section 2, Township 8 north, Range 32 west. This coal is from eight to fifteen inches in thickness, and is most probably the same coal which was struck in the well at the mill at Van Buren, in Crawford County.

From observations on the dip, which is towards the north, it is probable that this coal could be struck by shafts at all points in the prairie north of the Section previously mentioned, but runs out in a low synclinal to the south. All the coal, so far as my observation goes, found in the Garrison prairie, is too thin to be worked to any great extent, except for neighborhood use.

The most important locality of coal in Sebastian lies on the southern edge of Long prairie, known as the Jenny Lind coal, in the northwest and southeast quarters of Section 33, Township 7, Range 31 west.

The following is a section of this coal as it occurs at Greene's bank, in the northwest quarter of the above-mentioned Section of land:

	Feet.	Inches.
Rusty, ferruginous, gray shales, with segregations of iron ore, . .	5	6
A streak of black shale.		
A few inches of coal.		
A few inches of black shale.		
Upper member of the main coal, ...	2	5
Clay parting, ...		1
Lower member of main coal, ...	2	2
Coal rash (a few inches).		

This coal is, therefore, four feet seven inches in thickness, and is said sometimes to attain a thickness of five feet and over.

The following is the chemical analysis of a specimen taken from the upper member:

Volatile matter, ...	13.75	Water, ...	1.40
		Gas, ...	12.35
Coke, ...	86.25	Fixed carbon, . .	82.25
		Ashes (flesh color), .	4.00
			100.00

This coal swells up considerably in coking.

The dip of the coal and associate strata is north 40° west, at an angle of from 2° to 3°. The shale parting is full of the remains of stigmaria and sigillaria.

After exposure, the coal taken from the upper member frequently exhibits iridescent hues. It stands exposure tolerably well. If it were mined with more care, in rejecting the interlaminated shale and pyritiferous segregations, it would greatly contribute to increase the reputation and value of the coal in the market.

At Long's opening, on the southeast quarter of Section 32, Township 7 north, Range 31 west, the coal has the same thickness. The only difference is, that the clay parting is from half an inch to an inch thicker than at Greene's bank. The dip is nearly the same, north 35° to 40° west.

A specimen from this bank yielded by analysis:

Volatile matter, ...	14.50	Water, ...	3.80
		Gas, ...	10.70
Coke, ...	75.50	Fixed carbon, . .	84.10
		Ashes (light brown), .	1.40
			100.00

This coal swelled up a great deal in coking, and gave off a gas which burnt with a strong flame.

These analyses prove this coal to be semi-bituminous, like some of the coals in George creek valley, Maryland, and are far richer in fixed carbon

than most of the coals in the Western States; and therefore of course almost twice as durable in the fire with proper access of air. It contains just enough volatile combustible matter to keep it ignited without the artificial blast required for anthracite. If it can be mined free from pyrites and shale, it is one of the most valuable kinds of coal that can be offered in the market, especially for manufacturing purposes, if it be properly managed under a knowledge of its composition.

There is little or no difference in the level of the coal at the two openings.

The flaggy sandstone seen in the neighborhood of the Jenny Lind coal, seems to pitch under the coal, as no coal has been found by sinking under this rock. I regard it, therefore, as the equivalent of the flaggy sandstone underlying the coal in Johnson and Franklin counties. From the dip of the strata, the coal seems to pitch obliquely under the Long prairie, but probably rises and runs out in the flank of the ridge separating this prairie from the Massard prairie.

From the geological position of the Jenny Lind coal, there is no reason to believe that another workable coal could be found by sinking shafts under the level of this coal, since it occupies a position under the shales of the Millstone Grit, where only one bed of workable coal is to be anticipated; an opinion which has been confirmed by the palæontological observations, made last season, by M. Lesquereux.

The Jenny Lind coal is situated from eight to ten miles from the Arkansas river.* Both its quality and thickness must exercise a most important influence on the future prospects of Sebastian county, especially in the location of lines of railroad in the valley of the Arkansas river. I have already descanted on this elsewhere.

On Big creek there is a three foot coal, probably equivalent to the Jenny Lind coal, which is spoken well of by the blacksmiths.

In the ridge south of the Jenny Lind coal, judging by the dip of the strata and character of the rocks, the coal must run out. A sudden reversal of the dip, however, brings the coal in again on James's fork, and in Hodge's prairie. The summit-level between Long prairie and James's creek is two hundred and forty feet, and is composed of shale, capped with sandstone, dipping at an angle of 30°, south 10° to 20° east. A cellular sandstone is intercalated in the mass of the shale of this ridge; which rock I find persistent throughout this part of Arkansas, and is undoubtedly, when deep-seated in the synclinal troughs, a saliferous or salt-bearing sandstone.

The coal on the Sand ridge branch of James's fork, in Section 22, Township 6, Range 33 west, is owned by G. B. Morrow on the McMurtery estate. This coal, as far as entered, is three and a half feet, and seems to

* From the Jenny Lind coal to the Arkansas river, at the mouth of Vache Grasse, the distance is said to be only eight miles.

be increasing in thickness as it is followed into the bank. It is divided into two members of about equal thickness, by a shale parting of one inch, and rests on a bed of white clay. It dips nearly south towards the branch. The entry is on the west edge of the small McMurtery prairie; on the north side, about one and a quarter mile distant, is the Morrow coal-bank.

The succession of strata in the ridge between the Jenny Lind and the James's fork coal, appears to be as follows:

Thin-bedded and flaggy sandstone.
Heavier-bedded sandstone (the Greenwood building-stone.)
Cellular or saliferous sandstone.
Thinner-bedded sandstone with argillaceous flakes, containing Equisetaceæ and other fossil plants.
Variegated shales.

These strata, which geologically belong under the coal, must have a thickness of 500 or 600 feet or more. A measurement was made by the aneroid barometer, on June 20th, 1859, of the peak of the Sugar-loaf range, near the Line road, in the vicinity of Taylor's. It was found to be 1230 feet above Taylor's, and 1410 feet above Thomas Hicks's.

The structure of the mountain was found to be, approximately, as follows:

	Feet.
Schistose sandstone with intercalated bands of sandstone, ...	310
Conspicuous bench of heavy-bedded sandstone, ...	90
Dark-gray and variegated shales (easily decomposing), ...	800

From the summit of the Sugar-loaf Mountain, there is an extensive prospect into the Indian country on the west, with a perfectly conical peak in the foreground, a few miles beyond the Indian boundary, of considerably greater elevation than the peak measured.

On West creek, a branch of James's creek, a two-foot coal has been opened by the blacksmiths, at two different localities about two and a half miles apart.

A thick bed of coal occurs on James's fork, one mile north of west of Sugar creek Post-office, known as the More coal-bank. It is supposed to be six feet thick.

Three and a half miles east of More's mill, there is a good coal on the property of John R. Smoot, on the waters of James's fork. Also, at Squire Sorrel's, three miles south of James's fork, of which coal there is only about one foot exposed in the bed of the stream, but extending to an unknown depth below. The probable thickness is about two feet. Here, the coal dips at an angle of 4° to 5°, north 10° to 20° west.

There are a number of coal-banks in this vicinity, all within eight miles

of each other. I had an opportunity of examining a good natural exposure of coal three-quarters of a mile below More's mill, on James's fork. It crops out under a bank of variegated, ferruginous shales, with numerous thin bands of slaty and kidney hydrated oxide of iron. The coal is three and a half feet to four feet in thickness, and dips at an angle of nearly 1°, 10° to 20° west of north. There are black shale and coal-rash, measuring about nine inches, insinuated between the coal and the fire-clay. The coal lies fifteen feet above the waters of James's Creek.

A section of this bank is as follows:

	Feet.	Inches.
Sandstone with calamites,		
Variegated shales with iron ore,	21	0
Coal,	3	6
Black shale and coal-rash,	9 in. to 1	
Fire-clay,	1	0
Flaggy sandstone with calamites,		

This coal lies very conveniently for mining, as it can be worked without being incommoded by water, which is apt to be the case with most of the coals in this part of Sebastian county.

The flaggy sandstone forms the foundation of the dam at More's mill, where it dips east of south. No doubt the coal could be entered here, from the appearance of the black shale and coal-dirt in the crumbled bank.

On the northeast part of the northwest quarter of Section 26, Township 5 north, Range 31 west, is a four-foot coal on Cherokee creek, on the property of John R. Smoot. This coal is covered with three or four feet of gray shale, and dips nearly north 45°. This locality is convenient for mining, as the coal is in a sufficiently elevated position to be worked without being incommoded by the waters of the creek. An outcrop of coal is also seen on this creek, near the water's edge, but only about eight inches in thickness, and covered by a bank of solid shale, from twelve to fifteen feet in thickness.

Coal also shows itself on the southeast corner of Section 24, Township 5 north, Range 31 west; also on the southwest corner of Section 23, Township 5 north, Range 31 west, and can be traced for about half a mile, maintaining a thickness of about four feet.

On the southeast of Section 9, Township 4 north, Range 32 west, coal is again visible on the property of Timothy Bloodworth; also on Section 27, Township 5 north, Range 31 west. This latter bank is from twenty to twenty-five feet above the bed of the creek, and has never been properly opened so as to show its whole thickness.

It is probable that the whole of Hodges's prairie, north of these coal outcrops, is underlaid by this bed of coal, which could be reached by shafts of moderate depth.

From John Gillstraps's, in Hodges's prairie, there is a fine view of the

Cortes Mountain, which is the eastern termination of the Sugar-loaf range. See plate D.

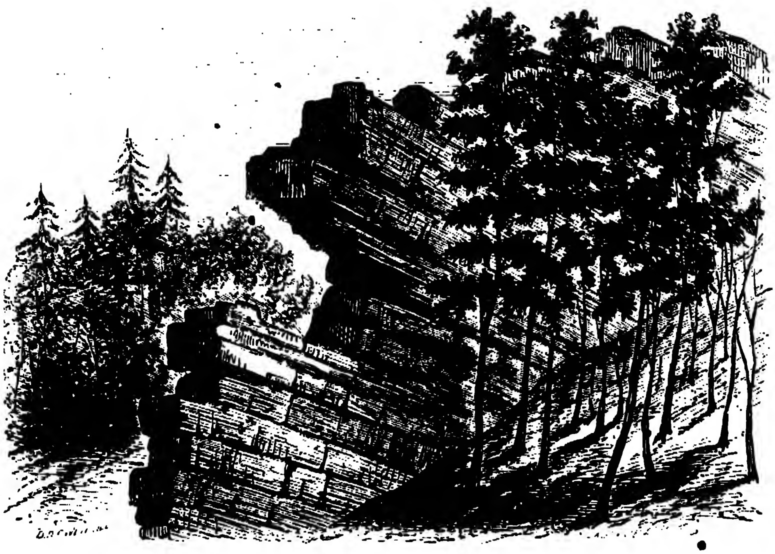
According to the statement of the inhabitants, this mountain was measured by Martin, the surveyor, and reported to be 1500 feet high.

A coal is reported on the Petit Jean, eight miles from Terman's, near the edge of Sebastian county.

A set of soils was collected for chemical analysis from Section 12, Township 5 north, Range 31 west, on Hodges's prairie, from the farm owned by John Gillstraps, where the red Sumach land prevails.

The results of the analysis are recorded in Dr. Peter's Reports, Nos. 351, 352, 353.

The coal-beds of Sebastian extend south into the base of the Poteau Mountains, but, so far as my observation goes, are of no great thickness in these mountains.



STANDING ROCK, BOARDCAMP CREEK, POLK COUNTY, ARKANSAS.

SECTION VI.

POLK COUNTY.

The northern part of this county is exceedingly mountainous. On the north it is bounded by the high range of the Fourche la Fave, which rises to a height of more than a thousand feet above the Poteau valley. South

of Dallas it is traversed by the complicated range of the Cossitott mountains.

There is no county in the State that exhibits stronger evidence of powerful internal convulsions and disruption of the strata. Almost everywhere the strata are highly inclined; and there are numerous instances of a nearly vertical position of the beds.

One of the most conspicuous instances is found on Boardcamp creek. At the third crossing of this stream, on the road from Dallas to Dr. Gilliam's, that conspicuous landmark, known as the Standing Rock, rises from out the crumbling shales, like an artificial piece of masonry, to the height of ninety feet above the creek, as shown in the woodcut at the head of this Section. The beds of the millstone grit are not only thrown out of their original position, but are highly metamorphosed. The main wall of the Standing Rock has been altered from a sandstone to a crisp, brittle quartzite, of white and smoky-gray colors, with sometimes a calcedonic lustre and appearance. This metamorphism has undoubtedly been produced by the prolonged action of hot alkaline, silicious waters, as explained in the first chapter when treating of the novaculites of Hot Spring County. The shales, doubtless from their impervious nature, are much less altered than the sandstones and grits. These are, however, in some instances, modified into argillo-silicious, or argillo-magnesian slates, more or less indurated; and near the confines of Arkansas and the Choctaw country, they have been altered into a fine quality of roofing-slate, fully equal, if not superior, to the best quality of Vermont slate, now an extensive article of commerce throughout the United States. Amongst other modifications of various varieties of sandstone and slate in the Cossitott range, we find a black, petro-silicious, flinty rock, having a prismatic or columnal structure. There are also layers of petro-silicious slate, as well as kiesel-schiefer.

The main mass of the east and west ridges of the Cossitott mountains is composed of hard quartzite, petro-silicious rock, and varieties of black slates, more or less indurated. The deep valleys have been scooped out of the softer shales, as they lie nearly turned on edge. For miles along the road, which winds along the base of the high peaks, following usually the course of some stream, you may travel upon the upturned edges of this wonderful development of the millstone grit formation, as it is exposed in an almost endless repetition of such masses of metamorphosed shales and sandstones, as above described, forming, perhaps, one of the most instructive examples of tilted and altered strata to be found in the United States.

One of the highest peaks of the Cossitott range, known as the Hanna Mountain, was ascended, and the height measured with the aneroid barometer. It was found to be 1000 feet above Cossitott creek, which washes the base. In the ascent of this mountain, immense parallel walls

of quartzite, and calcedonic chert, and dull, milky, cherty quartz, along with a hard and very brittle variety of novaculite quartz rock, may be followed running up the flanks of the mountain, with deep ravines of loose, crumbled, incoherent shales between, which are almost inaccessible. These rocks dip at an angle of 70°, north 20° west, the strike-line being west 20° south. One of these beds of hard, calcedonic quartz rises and forms the first bench on the mountain, 640 feet above the creek. The sag on the north of this wall is formed of red shales. The summit is white, calcedonic quartzite.

The Hanna peak has generally been regarded as the highest part of the range; but on sweeping the level on the summit of it, there are other peaks seen off to the east, three or four miles distant, which must be from seventy-five to one hundred feet higher.

Every one of the numerous peaks seems to be formed by a wall of hard, quartzose rock, running from the bases, obliquely, up the mountain, and cutting through the centre of the peak. This hard material has withstood the vicissitudes of time for ages; while the incoherent shales, disintegrating rapidly, are finding their way from the higher situations into the valleys.

These mountains might afford some fine varieties of hone-stone, if not too hard and too much fractured. There is one porous variety of silicious rock found in the vicinity of the Gap Springs, which might afford tolerable burr millstones.

If we may judge from the numerous axes of disturbance, and the peculiar character of the rock, there is every reason to anticipate the existence of minerals in the Cossitott range; more especially as there is considerable resemblance, in many points, between the formations of these regions, and some of the celebrated mining districts of the Hartz Mountains. As yet, however, no important discoveries have been made in Polk county, in the few rude attempts which have been made in exploring these mountains. We shall see, however, in a subsequent section, that on the southern borders of this formation, where it extends into Sevier county, there are metallic veins of interest and importance. Many a citizen from Carolina and Georgia has attempted to wash for gold in some of the gorges of the Cossitott range; but without any success, so far as I have been able to learn. Still, this country is so wild and broken, that metallic veins might be easily overlooked which could be discovered by systematic, detailed surveys. Some bodies of iron ore, pyrites, and plumbaginous slates, are all that I have yet seen, in the way of minerals, in this region.

There are several mineral waters in this county. Those of the Gap Springs, and Baker's Springs, are the best known. The Gap Springs were tested qualitatively at the fountain-head. They are alkaline, sulphuretted waters, very slightly impregnated with free, sulphuretted hydrogen. The principal constituents are:

Chloride of sodium,
Sulphate of soda,
Sulphate of magnesia,
Bicarbonate of alkali,
And probably a little sulphuret of alkali,
A trace of carbonate of lime.

An examination of the so-called alum spring, gave indications of the same ingredients, with the exception of the absence of sulphur, the presence of iron, and a larger proportion of sulphates. These waters will have a mild, aperient effect, combined with a slight alterative action on the system.

The qualitative analysis made at the fountain-head of the "Baker's Sulphur Spring," now owned by Major B. Hempstead, and situated in Township 5 north, Range 29 west, showed it to be an alkaline, saline, and sulphuretted water, containing as its characteristic constituents:

Carbonate of alkali, which is probably in the state of carbonate of soda,
Chloride of sodium,
A small quantity of free, sulphuretted hydrogen,
Traces of sulphate of soda and magnesia.

When boiled down it exhibits strong alkaline properties. Its medical properties are a mild laxative; a diuretic, antiscorbutic, slightly alterative, and strongly antacid. This spring rises from the slate at the base of a ridge of quartzose sandstone.

There are also several other mineral springs in this neighborhood, in Polk County. One at Samuel Gray's, on Section 20, Township 5 north, Range 29 west, its temperature 58°, the air being 52°. The main characteristic constituents of this water are:

Carbonate of soda,
Sulphuret of sodium,
Chloride of sodium,
Traces of sulphate of soda,
Traces of sulphate of magnesia.

Its medical properties will be found to be analogous to those of "Baker's Spring."

Nathan Aldridge's Sulphur Spring contains the same constituents, only differing slightly in the proportions.

Accounts are given of extraordinary explosions having been heard in Polk County, with other evidence of still slumbering igneous action; but whether any reliance is to be placed on them is still doubtful.

The town spring, at Dallas, was tested at the fountain-head, and found to be a tolerably pure water, containing only traces of carbonates, chlorides, and sulphates of the alkalies and alkaline earths.

Near Perren's mill, on the Saline, there is a white variety of iron ore, which is said to produce a very malleable iron.

Mr. N. Eldridge reports having found a piece of lead ore on his premises about the size of an egg. This locality lies very nearly on the line

of the vein of argentiferous galena, which will be spoken of in the Section under Sevier County.

In the vicinity of the "Baker Spring," the ridges of sandstones and shales of the millstone grit are of less elevation than in the centre of Polk County; and they continue to decline, southward, towards the line of Sevier County.

The ridges passed over, between "Baker's Springs" and Lebow's, had the following elevations above the Cossotott River: 350 feet, 380 feet, 450 feet, and 565 feet.

Along the "Line road," the soil produced by the disintegration of the sandstones and red shales, seems to be peculiarly congenial to the growth of the sweet potato; especially when, as is frequently the case, the surface soil is of a fine, loose, silicious nature, resting on a red clay.

At the time we were there, Mr. Lebow was just harvesting his sweet potatoes, which gave a yield of one hundred bushels to the acre, single potatoes weighing from three to four pounds.

A sample of this soil was collected for chemical analysis. Time has not yet permitted the completion of the analysis.

A set of soils were collected from Polk County, on the farm of Philip Cayle, Section 33, Township 2 south, Range 30 west; where the growth is red, black, white, and post oak, dogwood, black walnut, wild cherry, yellow pine, red elm, and hickory. These are rather red soils, derived from the red shales of the millstone grit. These have been analyzed, and are recorded in Dr. Peter's Report, Nos. 363, 364, and 365.

SECTION VII.

MONTGOMERY COUNTY.

The sandstones and shales of the millstone grit, in the middle part of this county, have suffered less from disturbance and metamorphism than in the preceding county. The sandstones appear in far greater development and heavier masses, forming a conspicuous part of the sections of the Crystal mountain.

I have already treated at length, in Chapter I, of the formation of rock crystal, which constitutes the most important geological feature of this county. It only remains to add here a few minor details.

Numerous attempts have been made at mining and exploring for ores at the head of Gap creek. These diggings have mostly been made where

a kind of chloritic slate is intersected by veins of quartz and calc spar; also at the junction of the slate and limestone.

Hardin and others struck some lead ore, on Gap creek, in crevices in dark-blue limestone, veined with white; after passing through a sheet of lead ore of about four inches they came upon a cap rock of limestone, which they went through; but finding no ore beneath this they abandoned the diggings. Some 400 lbs. of lead were obtained at this opening.

James Coggburn and others were induced also to undertake some explorations for ores in the Caddo mountains, but without any important result, having discovered only a variety of hydrated oxide of iron, presenting, as these ores often do, a superficial film resembling copper, and an imperfect kind of plumbago. The latter was struck in a pit, sunk twenty feet in a dark unctuous slate, known as Fitzgerald's diggings.

The vein of iron ore traverses a kind of smoky cherty rock in a northeast and southwest direction.

These discoveries, of little interest in themselves, are of importance as lying nearly in the course line of a metallic vein which traverses the greater portion of the State, and is described in the Section on Sevier County.

Near the terminus of the Crystal hill, near Dr. Johnson's, some silicious iron ore has been discovered at the junction of the limestone and slate. Some pieces of lead ore have been found on a branch of the Walnut fork, one mile southwest of S. Preston's.

The most fertile portion of Montgomery County is in Caddo cove, in the southwest corner of the county, where considerable bodies of subcarboniferous limestone reach the surface. It lies in the midst of slate, dipping at an angle of 28°, north 20° west, and varies from eight to ten feet in thickness. Sometimes this rock has a dark ground, veined with white, and is sufficiently hard to take a polish. In such situations marble of considerable beauty might be obtained.

A soil was collected for chemical analysis in Caddo cove, where the growth is beech and magnolia, but time has not permitted the analysis to be carried out.

Three or four persons, during certain seasons of the year, make a business of quarrying and blasting out rock crystal in the Crystal mountain of this county. It is estimated that they get out and sell about $1000 worth of rock crystal in the course of the season. This is disposed of, partly in specimens sold to the visitors at the Hot Springs, and partly to jewellers for gems and other purposes of the trade.

Several mineral waters in this county were tested qualitatively at the fountain-head as follows:

Mattock Spring, which issues from the slate in a ravine below Mattock's house, not far from limestone, is a strong alkaline sulphuretted water,

containing sulphuret of sodium, bicarbonate of magnesia (strong), bicarbonate of lime, chloride of magnesia, a trace of chloride of sodium and silica.

This water has remarkable effect on the tincture of Campeachy, due, I believe, to the reaction of the sulphuret of alkali present, and contrasting strongly with the same test added to the waters of Kates's creek, near by.

The Whisenaut Chalybeate Spring, near Kates's branch of the Ouachita, is an alkaline chalybeate, containing

Bicarbonate of iron,	Bicarbonate of soda,
Bicarbonate of lime,	Sulphate of magnesia (trace),
Bicarbonate of magnesia,	Sulphate of soda (trace).

This water has a slight deoxidizing effect on salts of soda.

J. B. Lemon's chalybeate water is a bold spring. It contains

Bicarbonate of iron,	Chloride of sodium,
Bicarbonate of lime,	(and perhaps a trace of)
Bicarbonate of magnesia,	Carbonate of alkali.

It has only a feeble deoxidizing effect.

Iron's Sulphur Springs are situated on the Sulphur fork of the north branch of the Ouachita. There are four principal springs which are situated within about half a mile of each other, known as the White, Black, and Red Sulphur, &c. They all contain essentially the same ingredients, but in different proportions. They are alkaline saline waters, with traces of sulphuret of alkali and free sulphuretted hydrogen.

VIEW FROM THE MOST ELEVATED OF THE NORTHERN GROUP OF HOT SPRING CREEK, LOOKING NORTHWEST.

SECTION VIII.

HOT SPRING COUNTY.

In Chapter I, I have already written at length on the origin of the Hot Springs and the Novaculite Rock in this County. There remain, however, some further remarks to be made on these and other subjects in this Section.

As the Hot Springs of Arkansas are of so much general interest, not only to the State, but to the people throughout the United States generally, I have prepared a Chart, representing the relative position of the principal springs, and giving their relative elevation above Hot Spring creek and their temperature; also the system of pipes and troughs by which their waters are conducted to the various baths and the public kitchen, indicating, at the same time, the general topographical features of the southern slope of the novaculite ridge from which they issue, and the surface of which is completely coated with calcareous tufa. This tufa, near the edge of Hot Spring creek, forms a conspicuous cliff, the accumulation of successive depositions during a series of ages.

The Chart is interesting, not only as affording evidence of the high temperature of the Hot Springs, but as demonstrating that the level of many of them is sufficiently high for the water to be conducted to the tops of the very highest building that might be constructed in the valley of Hot

Spring creek, so that the most convenient arrangements for distribution therein, for the purpose of baths, might be adopted, instead of the very imperfect and rude methods now in use.

This improved plan, by which all the medical advantages and curative properties of the baths would be greatly enhanced to the public, while the cost to individuals might be considerably diminished, would, no doubt, be fully carried out, were the property of the Hot Springs to be purchased by the State, or the United States,—a proposition which, I understand, has been already under public consideration.

As the temperatures were taken at different times with different thermometers, the temperatures given on the Chart are the means taken by Green's standard.

I have, however, appended a tabular list, with numbers corresponding to those in the Chart, and given not only the elevation in feet above the Hot Spring creek, but three columns of temperatures; those in the first column being the observations made on the 16th and 17th of October, 1859; in the second column, the temperatures by Green's thermometer, taken July 10th, 1859; the third column, temperatures by Taylor's thermometer, taken July 10th, 1859.

LIST OF HOT SPRINGS, HOT SPRING COUNTY, ARKANSAS.

NUMBERS CORRESPONDING TO THOSE ON CHART.

Numbers of Springs according to Chart.	Elevation in feet above Hot Spring Creek.		Temperat'rs, Oct. 16th & 17th, 1859.*	Temperat'rs by Green's Thermo. 10 July, 1859.	Temperat'rs by Taylor's Thermo. 10 July, 1859.
1	92	Northwest Spring, enclosed with stone (eggs cook soft in this spring), ...	146	143	146
2	93	13 feet, south 70° east, from No. 1, ...	121		
3		45 feet, 10° west of north, from No. 2, . . .	113		
4	91	Intermittent in temperature, ... 135° to	145		
5	90½	Near No. 4; distant from it only 15 feet, south 10° west,	106		
6	90	Also intermittent in temperature, 4½ feet, south 10° east, from No. 5, ... 108° to	112		
7	90	7½ feet, south 20° west, from No. 6, ...	134		
8	90	26½ feet, west 20° south, from No. 4, ...	144		
9		Just below old abandoned Mud Bath. . . .	119		

* These temperatures were taken with a thermometer by J. Kendall, which agrees with Green's standard, at ordinary temperature of the air, in July and October.

Numbers of Springs according to Chart.	Elevation in feet above Hot Spring Creek.	LIST OF HOT SPRINGS—CONTINUED.	Temperat'rs. Oct. 16, 17. 1859. J. Kendall's Ther.	Temperat'rs by Green's Thermo. 10 July. 1859.	Temperatr's by Taylor's Therm. 10th July, 1859.
10	82½	65 feet (about), south 45° west, from old abandoned Mud bath,	117		
11	82	Egg Spring, Bold Spring (eggs cook soft in this spring in from 15 to 20 minutes),	147	145	148½
12	86	Issuing from mound of tufa (eggs also cook soft in this spring),	146		
13	71	Due east of south end of Hale House, on Hot Spring creek, and 71 elevated above do.; supplies second Bath-house south of Pavilion Spring,	126		
14	81	Do.	110		
15	72½	Red Spring, near No. 14 and 13; 25 feet south 20° west from No. 14,	147	143	146
16	26	Main Hot Spring that supplies Clayton Bath-house,	148		
17	72½	Ferruginous, near cliff of sandstone,	120		
18	60	Issues from a mound of tufa, and supplies in part, Kitchen Reservoir,	126		130
19	42	Kitchen Main Hot Spring,	148		
20	45	Below Mud Bath House, or Pool of Bethesda; this spring also contributes to Kitchen Reservoir,	128		
21	32	Near No. 20, sends one branch to Clayton Bath-house, and one contributes to Kitchen Reservoir,	120		
22	10	Sulphur Spring, appears to be intermittent in temperature, 122° to	126		
23	3	"Alum" Spring,	133		
24	1½	"Hog" Spring, where hogs are scalded, close to Rector, Hale, and Clayton Bath-house,	148	145	146
25	9½	Arsenic Spring, comes out from under cliff of tufa, near Pavilion,	135	134	137
26		In bed of Hot Spring creek, inaccessible.			
27	1	Spring, just south of Warren Bath-house,	130		
28	1½	Do.	117		
29	6	Spring, behind do.	102		
30	7	Do.	120		
31	9	Pavilion Spring,	135	135	137
32		Mud Bath, near by,	106		
33	42	Mud Bath House, 42 feet up hill, opposite Clayton House, called "Pool of Bethesda,"	112		
34	7	Near Slab House,	118		
35	5	Just below do.	100		
36	6	Behind Old Hale Bath-house,	119		
37		Do. do.	119		
38	2	Do. do.	114		
39		In bed of Hot Spring creek, inaccesible.			
40	93	Gain's Spring, beyond limits of Chart, about 600 feet distant from the Sulphur Spring No. 22, and elevated 93 feet above Hot Spring creek,	120		
41	94	Small Spring, a few feet from No. 40,	120		
42	94½	Do. do.	120		

In the valley of Hot Spring creek, the rock is mostly slate, passing into a kind of Kieselschiefer, traversed sometimes by veins of Serpentine, which has been collected, in favorable situations, and wrought into small ornaments, such as brooches. The great mass of the Whetstone mountain, on the north, is composed of different varieties of Novaculite Rock, which is

quarried extensively to supply the neighboring Whetstone mills; but the greater quantity is transported to mills located at New Albany, Indiana, where it is sawed and fashioned into whetstones of every description, and razor honestones; the finer and harder varieties are reserved for the use of the engraver. These finer varieties seem generally to lie below the coarser.

On account of the fissured and fractured condition of the rock it is difficult to obtain large perfect blocks, free from hard quartz veins. Were it not for this circumstance it could be afforded at a much cheaper rate; I believe it is worth at the quarry, at present, about six cents per lb.

For the same reason it is difficult to distinguish the dip from the cleavage joints; the prevalent dip appears to be east, from 20° to 30° south, at an angle of about 42°.

The strike line of the mountain is very nearly northeast and southwest; say 20°, north 30° east.

The height of the Whetstone mountain is about 500 feet above the road leading from the Hot Springs to the Chalybeate Spring. The growth is several varieties of pine, oak, hickory and dogwood. About $3000 worth of this rock is cut out annually. The razor grit makes also a good whetstone for bench-tools, but is not so much used for this purpose on account of its high price, which is seven cents to eight cents per lb., delivered at Little Rock.

In some instances solid masses of the Novaculite rock have been got out weighing about 1200 lbs., which sold at the quarry for $2.50 per 100 lbs., or $3.00 delivered at Little Rock. The coarser varieties are usually wrought up into whetstones for bench-tools.

The old Ouachita quarries are situated two and a half miles north of the Chalybeate Spring; but very little is quarried there now, the rock being almost exclusively obtained, at present, at this Whetstone mountain.

One of the most interesting geological regions of Hot Spring County, and indeed of the State, is the Magnet cove, to which I have already alluded in Chapter I, in speaking of the principal localities of crystalline rocks throughout the State. This "Cove" is interesting, not only on account of the large body of magnetic iron ore which exists there, but also for the great variety of minerals and crystalline rocks which the region furnishes, of which a list is given in the first Chapter. Among them all the pure crystalline forms of Titanic acid are rendered the most important by their extensive use now in Dentistry. Some of the crystals of this mineral have been analyzed and proved to be as pure a form of Titanic acid, if not purer than any on record.

The centre and southern part of the "Cove," nearly on Sections 19 and 20, Township 3 south, Range 17 west, is a fine agricultural region, being the farm formerly occupied by J. S. Conway, and now owned by Mr. Mitchell. On the east part of Section 20, there is a great bed of magnetic

iron ore, some of which exhibits polarity. It is not exposed in a high hill or mountain, as in Missouri, but is on the same level with the cultivated fields adjoining, occupying a superficial area of the immediate surface of about eight acres; the ground over this area being exclusively covered with fragments and blocks of magnetic iron ore occasionally mixed with loadstone. Beneath the surface it extends to an unknown depth. It has been penetrated from four to five feet without finding any change of the material, except that the loadstones seem to be more abundant on the surface.

An analysis has been made of the magnetic iron ore with the following result:

Insoluble matter,	3.20
Moisture,	1.00
Peroxide of iron,	67.20
Protoxide of iron,	24.46
Manganese,	.30
Titanic acid,	1.20
Alumina,	.45
Lime, magnesia, and loss,	2.19
	100.00

The lapping of the arable land on the margin of the magnetic iron ore conceals its relation to the adjacent rocks; but from the minerals ploughed up in the fields on the south and southeast, the magnetic iron ore seems to be surrounded, in part at least, with mica slates. Along with the large flakes of this mineral, brought to the surface by the plough, are beautiful crystals of augite, and black garnets.

Adjoining the flucan of mica is a schorlamite granite. On the west part of Section 19, where this rock is exposed in the bed of Cove creek, some galena is reported to have been found; but none of any consequence was discovered when I examined the "Cove."

A short distance on the west side of Cove creek, on the west part of Section 19, a heavy vein of calc spar forms a low ridge, twenty or twenty-five feet in height. This calc spar can be traced 400 yards; and adjoining it, especially on the west, a great variety of minerals can be found, amongst which the ores of Titanium are the most interesting. Still further to the west and south, different varieties of granitic and augitic rocks prevail, succeeded on the northwest by the so-called "Mountain rock," passing into quartzite and novaculite.

On the west side of the "Cove," near Powers's stand, very pure specimens of crystals of Titanic acid were found. Half a mile beyond Powers's, on the Rockport road, the varieties of quartzite and novaculite rock commence, and continue most of the way to Rockport, where the novaculite

rock forms natural abutments on the Ouachita River, already mentioned in the first Chapter, and represented in Plate A.

On the south side of Ouachita River, Sections 34, 35, and 36, Township 3 south, Range 18 west, there is a complete labyrinth of high ridges, composed also of quartz and novaculite.

Towards the north, up Cove creek, the rock is mostly slate, mixed with a kind of greenstone trap.

On Moses Wood's farm there is a considerable vein of iron pyrites, which traverses a slate near the bed of Cove creek; this vein also contains some graphite and oxide of iron. Its course is 10° to 20° east of south. In the vein there is a kind of green soft flucan, composed of the debris of green talc and chlorite slate, and a light, porous, ferruginous, cherty rock, mixed with iron pyrites. The vein is about four yards wide. It is probable that the true course of the vein is very nearly north and south, since there is a strong magnetic disturbance, which prevents the needle from traversing, and deflects it, in some places, at least 45° to the east.

When Dr. Conway laid off the line between Moses Wood's and Ashbrook's place, he found the deviation so great that he had to make an offset before he could make a true north and south line.

Between the Hot Springs and Gulfer creek, on the road to Magnet cove, the rock is mostly reddish slate.

Near the Fairchild's Mineral Spring, the rock is a kind of quartz porphyry, amongst which a calc spar rock is also found.

This mineral water was tested at the fountain-head, and the main constituents found to be

Subcarbonate of soda,	Sulphate of magnesia (Epsom salts),
Chloride of sodium (common salt),	Bicarbonate of lime,
Sulphuret of sodium,	Trace of free sulphuretted hydrogen.

This is a very strong alkaline, saline, sulphuretted water; the alkaline effect being the most prominent in its medical properties.

The so-called "Upper Chalybeate Fairchild's Spring" was tested, and found to contain pretty much the same ingredients, only less sulphates. There was not much iron.

The Lower "Chalybeate" contains rather more iron than any of the springs, but still a very small proportion.

The so-called Sulphur Spring in the Magnet cove, on the property of Andrew Mitchell, Section 19, Township 2 south, Range 17 west, was also tested qualitatively at the fountain-head, and found to be an alkaline, saline water, similar in its properties to the Main Fairchild's Spring, but less strongly impregnated with alkalies.

Dr. Mitchell's Chalybeate Spring, on Stone-quarry creek, was also tested, and the main constituents found to be

Bicarbonate of iron,	Sulphate of soda,
Bicarbonate of lime,	Sulphate of magnesia,
Bicarbonate of magnesia,	Subcarbonate of soda.
Chloride of sodium (common salt),	

A mineral water was also tested one mile south of Powers's stand, and was found to be likewise alkaline, saline water, with a trace of sulphuretted hydrogen, the principal constituents being

Bicarbonate of lime,	Sulphate of soda,
Bicarbonate of magnesia,	Sulphate of magnesia,
Chloride of sodium (common salt),	Subcarbonate of soda.

This spring differs from the Mitchell Spring in containing less chloride of sodium.

About one mile north of Rockport, tertiary limestones make their appearance on the side of a hill, near the Chalybeate Spring. This is the most northerly point in Hot Spring County where I have been able to detect this formation, though the water in a well dug at Mr. Wood's place, in Magnet cove, is hard limestone water, so that it is not improbable that these calcareous rocks may be found further north.

Soils were collected for chemical analysis, both from Andrew Mitchell's and Wilmoth Mitchell's farms, viz., from Sections 20 and 19, Township 3 south, Range 17 west; but time has not yet permitted the completion of the analysis of these soils.

SECTION IX.

SALINE COUNTY.

The geological formation of this county is very analogous to that of Pulaski and Hot Spring counties, except that the slates of the millstone grit occupy a greater area in proportion to the silicious rocks.

As in Pulaski and Hot Spring counties, we have, in Saline, small areas occupied by crystalline rocks. One of the principal protrusions of granite in this county is in Township 2 south, Range 14 west. Some of this granite is quite porphyritic, the felspar crystals standing out in prominent relief on the weathered surface. Some of this granite has a graphic appearance, and there are occasionally disseminated through it crystals of hornblende and (schorlamite?) Some of this rock looks very much like zircon granite.

Several millstones have been quarried out of the above-named granite; the largest sized sell for $70 or $80.

The granite range bears northwest and southeast, and is about one mile across from north to south, and nearly four miles in length. It seems to be a continuation of that on the Fourche, though it cannot be traced uninterruptedly along the surface.

This granite soil yields forty bushels of corn to the acre.

On the south fork of the Saline, Squire Brooks and Dr. Cox, in exploring for minerals, discovered rocks of undoubted igneous origin, of the nature of trap and hornblende; as, for instance, on Section 32, Township 1 north, Range 17 west, with strong symptoms of metallic veins, containing ores both of lead and copper. But the explorations were so superficial that only a very imperfect opinion of the productiveness of the vein can be formed; it lies however nearly in the line of the metallic vein running from Pulaski to Sevier.

The slate in the vicinity of the vein is somewhat talcose and chloritic, and is traversed by veins of quartz much contorted, and shows evidence of reversal of dip.

The prevalent igneous rock of this region seems to be an augitic paste with imbedded crystals of hornblende.

On Lindsay's branch of the south fork of the Saline, near Mrs. Richardson's, granite was found in loose fragments; and on instituting a search higher up the creek, a black crystalline, overlying basaltic rock was found conformable with and insinuated between layers of argillaceous slate and a black calcareous rock difficult to distinguish externally from the basaltic rock itself.

On Mill creek, at Walter Lindsay's, on Section 26, Township 1 north, Range 18 west, search has been made for ores in a black plumbaginous slate containing alum and copperas, with oozings of oxide of iron. This slate dips north 34°.

On the same Section, near Lindsay's house, blue limestone, veined with white, crops out in the hollow and from the opposite bank; this will be of great importance to the neighborhood in an economical point of view.

Some hydrated oxide of iron, incrusted with a bright copper-colored film, has been found on this Section, of the same character as that found in the southwest corner of Montgomery County.

Mr. Walter Lindsay has devoted considerable time to crystal-hunting, and has found some very beautiful green quartz crystals in Saline County, on the mountain fork of the Saline.

Associated with the blue limestone of this part of Saline, there is a fine bed of gray limestone, with shining facets of calc spar, bearing west 20° south, and east 20° north. It is adjoining this gray limestone, and running parallel with it, that the principal body of the oxide of iron is found, which

is one foot thick at the surface, and widens from two to four feet on penetrating the vein.

The bed of limestone runs south of Iron Sulphur Spring, in a course a little south of west.

In the hills about this part of Saline County, gray sandstone prevails, traversed by veins of white quartz, and not unfrequently with drusy quartz between the joints and fissures of the rock.

Mr. Walter Lindsay informed me that he had panned for gold on Mill creek, between the bluff and the limestone, and obtained a small flake, which, however, I did not see, as he had sent it to his son.

The Alum fork of Saline receives its name from a conspicuous cliff of alum slate, exposed fifty feet in vertical height, with a talus of forty-two feet at its base.

In sheltered situations along this bluff, crystallizations of alum form and are collected by the inhabitants; hence the name of Alum Bluff. As the rock contains pyrites, crystallizations of copperas are also found here.

The slate lies horizontal, or with only a moderate dip of 2° to the east.

The Alum Bluff is situated on the northeast quarter of the southwest quarter of Section 33, Township 1 north, Range 17 west.

At the ford of the Alum fork, on the middle of Hot Spring road, the slate dips a little south of west, so that its bearing differs but little from north and south. Near the crossing of the Mount Ida and Upper Hot Spring roads, there is a prominent wall or dyke, three or four feet wide, of milky quartz, bearing nearly east 20° south and west 20° north, which must traverse the slate diagonally, since a few hundred yards to the east, the slate is seen dipping west in the bed of a branch, while in a branch beyond, the slate dips west 15° north, at an angle of 41°.

In the next hill limestone occurs, dipping at an angle of 26° or thereby. The limestone is of a dark bluish color, veined with white, as is usual with most of the limestone in this part of Saline county, showing itself in many places in the cuts of the Upper Hot Spring and Little Rock road.

On the head of Lost creek, in the neighborhood of Collegeville, and for several miles along the Camden and Little Rock road, there are considerable bodies of limonite iron ore, similar to that described in Pulaski County, which deserve the attention of the iron-master.

On Section 10, Township 2 south, Range 13 west, on the property of Alexander McPherson, is a considerable bed of compact lignite, which crops out at the source of a spring, and can be traced in the banks all around the basin of water. From the lowest point on the spring branch, where the lignite shows itself, up to the head of the spring, there is a difference of level of ten feet, but I have no idea that the lignite itself

has anything like this thickness; it is probably only from three to five feet thick.

The approximate analysis of the McPherson brown coal or lignite, gave as follows:

Volatile matter,	55.4	Moisture,	19.8
		Gas,	35.6
Coke,	44.6	Fixed carb.,	39.6
	100.0	Ashes (gray),	5.0
			100.0

Analysis by distillation of the same for the oil products from 200 grammes:

		In per cent.
Coke,	84.3	= 42.15
Crude Oil,	24.3	= 12.15
Ammoniacal Liquid,	50.3	= 25.15
Gas and Loss,	41.1	= 20.55
	200.0	100.00

Equal to 30.25 gallons of crude oil in 2000 lbs. of coal.

I have written at large in Chapter I of the relative values of coal oil.

The country around this lignite locality is mostly oak, hickory, and pine land, with occasional exposures of ferruginous sandstone and gravel of quaternary or tertiary date.

SECTION X.

SEVIER COUNTY.

Both in the physical features, and geological formation, the northern part of this county is similar to the southern part of Polk; and the appearance of the rocks is very much the same as that in the Bull Mountain, and on Kellogg creek, in Pulaski.

The Bellah mine is situated in the northern part of the county, on Section 21 or 22, Township 7 north, Range 32 west, four miles east of the western boundary of Arkansas.

In a direction very nearly east and west, where the slate in a fissured condition shows signs of disruption, metallic ores can be traced imbedded in crevices of the same character, in almost every respect, with those found at the Kellogg mine, in Pulaski: namely, argentiferous galena,

sulphurets and carbonates of copper, carbonates and sulphurets of zinc, red and brown oxides of iron, and iron pyrites.

Some years since, attempts were made to explore this vein. A ditch was sunk six to ten feet deep, and nearly one hundred yards in length. Some six shafts of pits were dug, which are now, however, abandoned and filled with water.

The debris about these old diggings prove that the vein must have been rich in these different ores, from the number of specimens strewed along the bank of the ditch and about the mouths of the shafts.

There is every reason to believe that this is the extension of the Kellogg vein of Pulaski County, which, appearing at intervals, but less marked in its characters, runs nearly across the middle and western part of the State, in a course more or less from northeast to southwest, and gives strong confirmation to the opinion formerly expressed, that the course of this vein demands a detailed geological survey; both to determine the precise course and ramifications of the vein, and to ascertain its promise of productiveness.

The argentiferous galena from this mine has been analyzed and cupelled, with the following results:

The average yield of lead, 73 per cent.
This lead cupelled, yielded in proportion 52½ ounces of silver to the ton of lead.

The qualities of argentiferous galena are very various in this vein, and no doubt, there are portions of the ore, that would yield a much higher percentage of silver.

As there was no one at the mine, or in the neighborhood, who could give me any reliable information regarding the work that had been done in former times on this vein, I addressed a letter to Richard W. Bellah, now residing in Texas, one of the principal owners, and the person who had conducted most of the work, in order to obtain some statistics.

He writes, that there were three principal shafts sunk, two of which were thirty feet deep, the other seventeen feet. The ore he considered to be in a continuous vein, increasing in thickness as far down as he went. Several other shafts were sunk from six to twelve feet deep, and he reports the ore to be continuous also in them. Mr. Bellah could not give the exact amount of ore raised; but he is of opinion that it was five tons, or perhaps more.

He states, also, that there were not as much of the green and blue carbonates and sulphurets of copper, after going sixteen feet, as appeared near the surface of the ground. He sent a portion of the ore to Liverpool, England, to be tested, and received a statement in return to the effect that the ore yielded 73 per cent of lead and 148 ounces of silver to the ton.

Although Mr. Bellah had to abandon the mine, and move to Texas, he

seems to put a high value upon the property, as he says: "I am not willing to lease the mines; but I will sell for a reasonable price, provided my brother and sister will sell at the same time, which I have no doubt they will. I have put a price upon the mines, and value it altogether at $10,000.

"There are 460 acres of land in our claim, the title of which is perfectly good."

Near the Indian boundary line, and about four miles from the Bellah mine, and some distance beyond the Indian line, an excellent quality of roofing slate occurs in the Mountain fork of Little River. This slate I have carefully compared with the best Vermont slate, and find that it is fully equal, if not superior. A similar quality of slate, and probably an extension of the same range, occurs on the Rolling fork in Sevier County. This slate has very much the color and appearance of Welsh slate.

As you proceed south in Sevier County, the elevation of the country gradually declines until you arrive at the confines of the Cretaceous formation, in the vicinity of Ultima Thule; where there is an entire change in the soil, and the surface is either gently rolling or level.

The country around Ultima Thule, both in Arkansas and over the line in the Choctaw country, is all based on limestone, or marly limestones of the cretaceous period; and flats, as well as extensive licks indicative of salt, are frequently encountered. I tested the Graham salt water, and found it to be a strong brine. Salt was formerly made here; but the works have been abandoned, probably because no pains were taken to tube out the fresh and weak water; or because the borings were not carried to a sufficiently great depth. The salt water rises through the gryphæa beds of the cretaceous formation, of which forty feet are exposed in the slope of an adjoining low ridge, on which repose red clay and gravel, thus:

Coarse gravel and red clay, 25 to 30 feet,
Cretaceous (Gryphæa) limestone.

The rise of the salt water appears to be in connection with some axis of dislocation.

From the Graham salt-well we ascended an oak ridge, on the slope of which occur red, chocolate and greenish-yellow earths, with a little fine gravel. Some of these earths are evidently quite calcareous.

The growth on the ridge is mostly post-oak, and the surface very level, forming, in fact, a kind of table-land, with evident symptoms of the vicinity of salt water. This kind of country continues for four miles; beyond which we arrived suddenly at a rich, black, sticky, cretaceous soil, on the edge of William Holman's plantation.

These black lands have the same origin as all the black lands I saw within the boundaries of the cretaceous formation; having been derived from a fresh-water silt, deposited in lakes, ponds, and pools, that formerly

existed in the depressions and hollows of the cretaceous rocks; as is proved in almost every instance by the multitude of small fresh-water and land-shells strewed almost everywhere along the borders of these lands. These black lands are exceedingly fertile; but if they are located so that the black soil is washed away into low situations, laying bare the purely cretaceous soil beneath, their fertility is greatly impaired, for reasons which I have elsewhere explained.

A set of soils was collected for chemical analysis on William Holman's land, in Section 12, Township 12, Range 32 west, and will be found recorded in Dr. Peter's Report, Nos. 366, 367, 368.

These soils are most remarkable, on account of the large percentage of carbonate of lime in their composition, amounting, in the virgin soil, to nearly 36½ per cent; in that of the old field, to over 66 per cent; and in the subsoil, to over 79 per cent. The effect of this large amount of lime is rapidly to exhaust the soil of its organic principles, and proportionally to deteriorate its fertility, unless a full supply of organic manures be put upon the land. It has also a parching effect, both from the rapid evaporation and from the strong reflection from its white surface. For further remarks, the reader is referred to Dr. Peter's Report.

The growths on this cretaceous soil are: bois-d'arc, haw, hickory, sumach; the undergrowth, scrubby swamp dogwood. On this soil twelve to fifteen hundred pounds of cotton are raised to the acre; thirty-five to fifty-six bushels of corn; twenty bushels of wheat. In the fields of Holman's farm fossil exogyræ, weighing several pounds, are strewed in every direction over the higher grounds.

The tract of post-oak land passed over before reaching Holman's is four or five miles wide from north to south, and six or eight miles long from east to west. It has a cold and wet soil, but could be greatly improved by thorough drainage and mixing with some of the calcareous soils of the adjoining cretaceous formation.

Sets of soils were also collected from the genuine "black sand" cotton lands of the Red River bottom, near Lanesport, on Section 12, Fraction of Township 12 south, Range 33 west, from land owned by Col. David Hamiter, considered part of the best cotton land on Red River. These soils have been analyzed, and will be found recorded in Dr. Peter's Report, Nos. 329, 330, 331, 332; they prove to be remarkably rich.

No. 330, the soil from the old field, has been fifty years in cultivation without as yet exhibiting much sign of deterioration, for reasons which I have explained in full in the first chapter of this volume.

No. 332 is a sample of the red cane land, containing a mixture of clay and sand colored by oxide of iron; and though not so loose to work, is hardly less fertile than No. 329, and is undoubtedly more durable. In dry seasons, it is admitted to produce better crops of cotton.

Crops of cotton, raised from the Boyd seed, have yielded 325 bales from 250 acres. The average crop, however, is considered to be from 1500 to 2500 lbs. of seed cotton to the acre; but there is always a great loss from the cotton falling to the ground before it is gathered.

These soils, no doubt, rest upon the cretaceous formation, which can be traced from Rocky Comfort to the very edge of the Red River bottom, passing there under the alluvium, but too deep to be visible anywhere in the bottom; so far as I have seen.

These alluvial lands of Red River result mainly from the sands and red, saliferous silts brought down from remote regions and partially mixed with debris and washings from the adjacent cretaceous formation.

At Rocky Comfort the rock is a kind of chalk-marl, containing numerous inocerami and spatangi. This rock can be easily cut and carved with edge tools into any required shape, and hardens by exposure; but it does not stand either fire or frost.

There are about 100 feet of chalk-marl and marly limestone exposed about Rocky Comfort.

The black lands over these cretaceous beds are fertile; but where these calcareous strata come fairly to the surface they are too hard, white and impenetrable and contain too much carbonate of lime to be productive. They could be made so, however, by proper tillage, drainage and admixture with the adjacent sands of the quaternary; and they will answer admirably as mineral manures when added to those sandy lands.

A considerable variety of fossils occur in the marly limestone of Rocky Comfort; but they are mostly internal casts of Inocerami, Baculites, Ammonites, and Echinoderms.

The bois d'arc and black haw seem to flourish everywhere, even on the bare cretaceous beds. The former attains a considerable size, and is used for making wagon-wheels; when well-seasoned and firmly joined, it wears almost as well as iron, and acquires a polish by long use.

After leaving Rocky Comfort in the direction of Paraclifty cretaceous strata are seen, at intervals, for a mile and a half. These are then concealed, except locally, by coarse sand and gravel of the quaternary formation. The growth is at first oak; but before reaching the saw-mill, oak and pine prevail. Six or seven miles from Rocky Comfort we passed through some deep sand with a stunted growth of oak and pine. No solid rock is seen here, not even at the crossing of Little River. After passing this stream we travelled for nearly two miles through bottom land bearing high cane and a variety of fine timber, amongst which were some large pine.

About Brownstown the marly shell limestones prevail, as at Rocky Comfort, with occasionally some black land south and east of Brownstown.

About Paraclifty there is a pine ridge with coarse gravel on the surface. This reaches 260 feet above Little River. No ledges of solid rock are

D. D. Owen del.

Lith. by A. Hoen & Co. Baltimore.

NATURAL ABUTMENTS OF THE WHITE NOVACULITE ROCK ON THE OUACHITA RIVER, AT ROCKPORT,
HOT-SPRING COUNTY, ARKANSAS.

visible in the vicinity of Paraclifty. Two miles from this place is a descent from the ridge of coarse gravel on to red clay; then succeeds a soil which looks quite calcareous, but no limestone is visible. About half way down the slope some iron ore makes its appearance; but most of it is too silicious to be wrought with advantage in the furnace.

About four miles from Paraclifty the marly cretaceous limestone is seen in a ravine partially covered with coarse gravel.

The ridge at the forks of the Washington and Centrepoint road, near Dr. Wilson's, is 280 feet above Little River. Within ten feet of the top of this ridge the white calcareous soil indicates the close proximity of the cretaceous formation; covered, however, on the higher grounds with gravel. Rising from here 50 feet the cretaceous strata are visible about 30 feet up the slope or 310 feet above Little River.

On the waters of Sandy creek, on Section 22, Township 10 south, Range 29 west, soft quaternary sandstone prevail, resting on dark sandy shales and argillaceous shales.

The succession, in the eastern part of Sevier County, between the Cossitott and Saline, seems to be:

First, Coarse gravel.
Second, Contorted sandy and dark argillaceous shales.
Third, Cretaceous marly shales and soft cretaceous limestone.

On a live-oak flat, on Section 22, Township 10 south, Range 29 west, is an old salt well which gives a strong reaction of chlorides with nitrate of silver. The principal constituents of this water are:

Chloride of sodium,	Bicarbonate of alkali,
Bicarbonate of lime,	Chloride of magnesia,
Bicarbonate of magnesia,	Trace of sulphates.

It is said that, at one time, with thirty-two kettles, of thirty-five gallons each, twenty bushels of salt were made daily for three months; and that it afforded a dry, white salt. There is very little doubt but that with proper management and perhaps deeper boring and tubing salt could be made here with profit.

Salt water also occurs on Section 18, Township 10 south, Range 28 west, in the flat near S. T. Britt's house. This farm is situated on the quaternary sand and gravel, underlaid by red clay. On this land they produce about 300 lbs. of ginned cotton to the acre.

One and a half miles beyond this farm ferruginous quaternary sandstones, occasionally fluted and sometimes perforated with cylindrical tubes, lie scattered on the surface in the pine woods, mixed with some ferruginous conglomerate. This formation prevails to the Hempstead line.

SECTION XI.

HEMPSTEAD COUNTY.

This county is based mostly on the Cretaceous Formation, which is indeed here better exposed and developed than in any county in the State. It is covered up locally, however, by the sands and red clays of the quaternary formation. Entering this county from Greenville the black lands commence two or three miles southeast from that place, and a mile and a half or two miles from Dr. Amos Walker's farm.

This farm is based on the exogyra marls of the cretaceous formation. In the hollows we find, locally, black soil with the usual land and fresh-water shells. All the material exposed on this farm is of a marly character, replete not only with the abovenamed fossil, but with Baculites, Ostrea, small Inocerami, and Pectenquinque costata. Twenty feet above the shell marl at Amos Walker's these cretaceous marls are covered with a few feet of red clay and gravel.

At Ned Johnson's old farm, the marly limestones of the cretaceous formation are finely exposed, filled with a variety of cretaceous fossils. The face of the country here is like that of the chalk downs of England. As usual, the bois d'arc is the characteristic growth.

Where the country is level the black soil prevails; but where the country rises into rolling ridges this soil is washed down into the low situations, greatly impairing the fertility of the land.

An extensive belt of the Exogyra beds of the cretaceous formation extends a few miles north of Washington, in the vicinity of the Burt & Smith settlement, and running towards the high ridge south of Marlbrook, and west towards Columbus. This is the locality where most of the fossil bones were found in Arkansas in the early settlement of the country. They were almost universally ploughed up in the fields on the highest part of the ridge, and generally where the fossil Exogyra and Ostrea were most abundant; they consisted mostly of detached bones of vertebral columns of fishes of the shark family, and Saurians allied to the Zeuglodon.

Several years since Dr. Koch travelled in that country and collected all the bones he could find on the plantations. He also got permission to plough the fields in search of more; but I believe, from what I could learn, without much success. He managed, however, to carry away all the bones that were then in the country, and made arrangements that those which might be found hereafter should be boxed up and sent to him. This collection was unfortunately taken by him to Berlin, so that the comparative anatomists of this country had no opportunity of examining them. Some

of these bones belong to a huge Saurian. Dr. Leidy, of Philadelphia, succeeded afterwards in obtaining some imperfect specimens of vertebræ, apparently of the same Saurian, which he was requested to examine and report on. He characterized them, as well as circumstances would permit, under the name of Brimo-saurus. (See Proc. Acad. Nat. Sci. Phil., 1854.)

We succeeded in procuring a few imperfect bones, but none sufficiently well-marked to serve for description.

Here, as elsewhere on the high, rolling ridges, the cretaceous soils have too large a proportion of carbonate of lime to be very fertile, unless under a judicious system of tillage, drainage, and admixture of sand and manure.

A set of soils was collected for chemical analysis from Section 7, Township 11 south, Range 25 west, from the farm of Dr. Smith, near the old military road leading by Justus's mills. These soils have been analyzed and will be found recorded in Dr. Peter's Report, Nos. 326, 327, 328. The analysis of this set of soils is very instructive, showing how rapidly the relative proportion of carbonate of lime increases in the soil by cultivation and washing. In the virgin soil, No. 326, the carbonate of lime amounts to only 2.415; but the soil from the old field, No. 327, contains 35.400; and in the subsoil, No. 328, the carbonate of lime amounts to 50.240.

Immediately south of the Cretaceous formation, in the vicinity of Washington, there appears to be a Tertiary clay, which has been struck in a well sunk on the northern confines of the town. This is in turn completely covered up by a loose sand, probably of Quaternary date, and almost white. Some of this was collected for analysis, from General S. D. Royston's yard, near his office in town. This has been analyzed, and will be found recorded in Dr. Peter's Report, No. 337; where it will be seen that the sand and insoluble silicates amount to 97.295 per cent. Still, as Dr. Peter remarks, there are enough of the elements of vegetable food to afford a growth by no means scanty.

Several mineral springs and well-waters were tested: namely, Judge Hubbard's spring, on Section 13, Township 10 south, Range 23 west, two to three miles north of Prairie D'Anne. This water was found to be a weak saline chalybeate, containing

Bicarbonate of iron,	A trace of chloride of magnesia,
Chloride of sodium,	A small quantity of sulphate of soda and magnesia.

Its medical properties will be slightly tonic and aperient.

A water from the well on Lowry's lot, on the north edge of the town of Washington, was also tested; and the constituents found to be

Protoxide of iron, partly held in solution by carbonic acid, and partly by an organic acid,	Traces of sulphate of soda and magnesia,
Chloride of sodium,	Bicarbonate of lime,
	Bicarbonate of magnesia,
	Carbonate of alkali.

The medical effects of this water will be tonic and slightly alterative, and it is a corrector of acidity.

A qualitative examination was also made of a mineral water from a well on J. D. Morrisett's plantation, situated on Section 25, Township 10 south, Range 25 west. This water is strongly impregnated with the sulphate of magnesia, which is its characteristic ingredient, along with some

Chloride of sodium,
Bicarbonate of lime,
Bicarbonate of magnesia,
Carbonate of alkali.

This water is very similar to the celebrated Harrodsburg water in Kentucky. Its effects will be chiefly laxative, and at the same time corrective of acid reactions in the system.

E. Merrick's water, about three miles a little west of south of Washington, was also tested. It rises in a spring out of the sandy lands, and its constituents are

Chloride of sodium,
A trace of bicarbonate of lime,
A trace of bicarbonate of magnesia.

Its medical effects will therefore be very feeble.

A few Artesian wells have been bored in Hempstead county. One at William Craven's, not far from the edge of Prairie D'Anne, was sunk four hundred feet, and a strong mineral water when struck rose and now flows off two feet above the surface of the ground.

McFadden sunk a well four hundred and fifty feet deep, two miles west of Washington; but obtained no water.

An Artesian well was also sunk two hundred and seventy-six feet deep, on the farm of A. Hannegan, Section 25, Township 12 south, Range 25 west. This water I had an opportunity of testing, and found it to contain, as its principal constituents,

Chloride of sodium,
Carbonate of soda,
Sulphate of soda,
Sulphate of magnesia,
Traces of carbonate of lime and magnesia,
Trace of free sulphuretted hydrogen.

The Marlbrook farm is situated on the cretaceous strata; but Judge Cross has his residence in the pine woods adjoining, where the cretaceous strata are covered by a loose sand, as at Washington.

The geological section on this farm seems to be,

White sand,
Gray sand based on red clay, often with gravel, some of it water-worn and some angular,
Olive-gray marly sand,
Hard calcareous concretions and bands, with olive-gray sand and dark marly clays in two to three alternating beds,
Grayish-brown sandy marl,
Light-gray or nearly white cretaceous marl.

Passing south of Washington, after leaving the sand, we come down upon a dark stiff tenacious soil, based on the blue marly clays of the tertiary period, in which some good iron ore is disseminated.

Three to four miles north of Spring Hill we again reach the sandstone and sand which form pine ridges in the vicinity of Major Prior's. In the bed of Caney creek, however, there is a calcareous rock which the Major has used for building purposes. This rock probably underlies the black calcareous soils previously spoken of.

Half a mile from Major Prior's lignite has been struck at Colonel Finley's, twenty-two feet under the surface. In digging the well Colonel Finley went through orange-sand and gravel two or three feet; reddish sand fifteen or twenty feet; white pipe-clay two or three feet; and lignite three or four feet.

In the orange-sand large masses of silicified wood are found, which show the structure of the wood distinctly.

In a cut in the road near Spring Hill the following section was obtained:

White sand and gravel, one or three feet,
Orange sand and coarse gravel with silicified wood, ten or twelve feet,
Yellow and ash-colored sandy-loam, fifteen to twenty feet,
Ash-colored, tenacious, marly clay, with segregations of good brown ochre, two to four feet,
White pipe-clay, two or three feet,
Lignite, three to four feet.

On the high grounds at the Walnut Hills are sandy pine lands resting on red and ash-colored clays. Along Red River in this county the alluvial lands are generally sandy loams, much of the same character as those on the Lost Prairie in Sevier county except that they are somewhat more argillaceous.

The celebrated Red River Raft commences twenty or thirty miles below Walnut Hills. Shreve cut a channel a hundred miles long entirely through this raft; but the first high water blocked it up for thirteen miles. A company is now forming to open it again and keep it open by a toll of fifty cents on each bale of cotton.

One and a half miles from Spring Hill ferruginous sandstone occurs in numerous loose blocks partially imbedded in a red clay, as seen in the cut of the road for about twenty feet; higher up in the pine ridge, ferruginous conglomerate is also seen.

No shell beds were found in connection with any of the partial sections exposed in the vicinity of Spring Hill. This seems to be the limit of any surface indications of the cretaceous formation in Hempstead County.

There is a fine spring at Major Prior's which has a temperature of 66½°, the air being at the same time 75°.

Large quantities of silicious iron ore occur four miles from Dulay's ferry, associated with ferruginous and fluted sandstones.

The Red River bottom, from ten to fourteen miles wide, extends from Dulay's ferry to McKinney's creek. On the southwest side of this creek there are broken pine ridges, like those in the southern part of Hempstead, between Spring Hill and Red River bottom, but rather more broken. These extend to the Sulphur fork.

The Red River alluvium, between Fulton and McKinney's creek, is mostly black sand land.

The materials exposed in the cuts of the road descending from the pine ridges to the Red River bottom are:

White and gray sand,
Orange sand,
Ferruginous sand, sandstone conglomerate, and silicious iron ore,
White silicious pipe-clay.

The whole descent to the bottom is from a hundred to a hundred and thirty feet.

Ascending from the Red River bottom to the Lewisville road both the clay and sand are very red; some of it, if washed, might answer for a paint. The subsoil under the pine ridge is also very red; but three miles on the road, where the ferruginous sand makes its appearance, the subsoil is of a light-ash color in the hollows, though still somewhat red under the soil of the ridges. This continues to be the case for five or six miles.

There are about seventy or eighty acres northwest of Lewisville, in Township 15 south, Range 24 west, very much like the land at Smith's south of Washington.

In sinking wells at Morgan Cryer's a pipe-clay is reached which seems to run north and south in a narrow streak. No lignite has yet been found here.

On Boyd's farm, on a high point of land, a ferruginous sand and conglomerate are again visible.

The alluvial lands constituting the Long prairie, on Red River bottom, are said to be ten miles long from north to south, but only about one mile from east to west wide upon an average. West of these are stiff red cane lands; east of them are the Hog-wallow marshes, subject to overflow.

SECTION XII.

CLARK COUNTY.

A considerable proportion of the northern part of this county, that is, in Range 6, is based on tertiary limestone.

One mile south of west of Rockport this is a compact shell-limestone, lying almost in immediate contact with either quartzite, kieselschiefer, or novaculite slate. At one point the novaculite can be seen immediately underlying the limestone, unconformably.

The country on the west side of the Ouachita, along the military road leading from Rockport to Dr. Physic's, is very much like that near Little Rock in Pulaski County. Debris of gravel of different kinds, weighing from a few ounces to ten or twenty pounds, are strewed over the surface, and probably rest on slate and novaculite. The only place where the slate was seen to crop out was about one mile north of Dr. Physic's.

In the vicinity of Arkadelphia the cretaceous strata make their appearance and underlie all the black lands south and west of that place.

J. D. Allen's limekiln, one and a quarter miles from Arkadelphia, on Section 8, Township 7 south, Range 19 west, on Mill creek, is built on the cretaceous limestone. The upper layers, for three feet, are thin-bedded limestones alternating with an ash-colored soft marly rock. The lower part, about twelve feet in thickness, is a more solid limestone, from which the lime is burnt.

This range of cretaceous rocks can be traced about three miles in a southwest course, and one mile to the Ouachita. Here we found the Exogyra costata and the internal casts of a few other cretaceous forms.

On rising above the level of these cretaceous rocks they are found to be covered by red clay and some large rounded gravel.

Mr. Boseman's farm, on Section 28, Township 7 south, Range 20 west, is based almost entirely on cretaceous rocks, the upper beds being a marly limestone with the usual cretaceous fossils, overlaid, as above stated, by red clay and gravel.

Forty to fifty feet lower down, on Decepier creek, are more solid varieties of cretaceous limestone, some layers of which are complete agglutinations of marine shells. There are at least sixty feet of cretaceous and marly limestones exposed at Col. Boseman's, the upper beds characterized, as usual, by the Exogyra costata. The upper layers, as has been said, are

usually covered with red clay; but near the centre of one of Mr. Boseman's fields there is a light silicious marl full of fresh-water and land shells, mostly univalves such as are usually found on the margin of the black lands. This deposit seems to be unconformable with the cretaceous rocks, and to have been washed down the slope.

Where the soil of this farm is unmixed with red clay, sand, or silicious marl above, it does not produce nearly as well as when it has an admixture of these other earths, for reasons which I have fully explained elsewhere.

The marls and marly limestones, though too calcareous in themselves, would make good mineral manures for both loose sandy soils and stiff clay lands.

Samples of the genuine cretaceous soil were collected in sets on Col. Boseman's farm. They have been analyzed and recorded in Dr. Peter's Report, Nos. 343 and 344. They do not exhibit so great an excess of carbonate of lime as many other cretaceous soils; that numbered 334 contains the largest percentage, viz. 35.950; but the virgin soil does not rise above 3.75.

A soil was collected on Buckner's farm, of the genuine black, sticky wax land, in Section 19, Township 8 south, Range 19 west, and will be found recorded in Dr. Peter's Report, Nos. 341, 342.

Several Artesian wells have been sunk in the black lands in this county. Where Evans went down two hundred and eight feet, forty feet consisted of black earth; in fact the whole distance, with the exception of one foot, was of the same nature. The one foot was solid rock, in which water was struck, which soon rose to the surface and now runs over a little all the time. The water is impregnated with salts and sulphur.

Mrs. Anderson bored one hundred feet on Section 13, Township 8 south, Range 19 west. Water was obtained, but it only rose to within twenty feet of the surface.

Mr. Adams bored one hundred and ninety-two feet, all of the way through black earth, except the last six inches through rock, when water came up. This water has a sulphurous smell, but does not taste much of mineral impregnations. The extraordinary amount of black earth passed through in this boring is worthy of note, as indicating the immense amount of lacustrine silt deposited in the hollows and depressions of the cretaceous formation. The soil is said to be fully as rich at the bottom as it is at the top. The farms situated on these black soils are, as might be expected, very productive.

In the rich woods of Clark, on Section 19, Township 8 south, Range 19 west, the soil produces fifty bushels of corn to the acre, and about twenty bushels of wheat.

The section of the cretaceous formation, as far as it could be seen at Col. Boseman's, was as follows:

Exogyra bed,	15 feet.
Exogyra and Spatangus beds,	15 "
Crenulated oyster bed,	8 to 10 "

Water is obtained at Col. Boseman's at forty feet, in a red clay and gravel, being held up by the impervious cretaceous layers below.

The materials which formed the dark-gray marly beds, lying in low situations around the Boseman farm, have no doubt been derived from the debris of the millstone grit.

The high grounds lying between the cretaceous formation of the Boseman farm and the country of the black rich woods, is occupied by red clay and gravel, and occasionally sand and gravel, until the post-oak lands are reached, bordering on these woods.

The cretaceous formation in this part of Clark County is carved into rounded hills with sloping sides more or less abrupt.

Three miles southwest of Col. Boseman's both the Exogyra and the Oyster beds are exposed, lying about forty feet apart. They are seen also in various places along Little Decepier creek; the matrix here being of a lighter color than usual.

At the Limekiln, five miles from Okalona, cretaceous limestone is found and burnt to lime for neighborhood use. Here the rock is very solid and full of imbedded shells, echinoderms, and corals.

The cretaceous strata show themselves also in other places between the limekiln and William Ross's.

Mr. Ross's dwelling, situated on the highest ground, stands upon sand, gravel and red and gray clay; but along the lower slopes and in the cultivated fields the cretaceous formation exists. There are often found here, the land and fresh-water shells which border on the black lacustrine soils.

The section exposed in sinking Mr. Ross's cistern was

Sand, gravel,	15 feet.
Blue cistern clay, about	10 "
Red clay and gravel, about	10 "
Cretaceous marl,	
Shell and oyster beds,	
Cretaceous clay.	

An Artesian well at Mr. Cargill's, on the hill near Okalona, was bored through the following strata:

Soil and subsoil, ...	5 feet.
Gray or ash-colored marly limestone, containing black fossil Turrilites, Ostrea, and other shells. This is the so-called "Blue-rock" which prevails along nearly the whole depth of the boring, ...	303 feet.

Water was obtained at three hundred feet, in a hard cellular sand-rock, which, however, soon gave way and caved in. Then Mr. Cargill undertook to build a large cistern, thirty-eight feet deep, which promises better success.

SECTION XIII.

PIKE COUNTY.

The northern part of this county is composed of tolerably high ranges of sandstones, and shales of the millstone grit, which extend as far south as the site of the cotton factory. South of this the Little Missouri meanders through the cretaceous formation.

In the first chapter, I already described the small volcanic tract south of Murfreesboro, and have only a few remarks to add here.. Judge White has sunk a shaft twenty-one feet through the porphyritic rock, and exposed here and there small particles of titaniferous iron.

The needle is strongly deflected over the shaft, which is about eight feet in diameter. No other metallic ore has been discovered in the vein, except some small particles of lead ore found in the rubbish near the shaft. This shaft presents appearances not unfavorable to mining operations; still, no regular vein seems to have been struck in the depth reached. The openings where the ore has been found are some three to five inches wide, and mostly filled with greenish-brown wacke,—the result of the decomposition of the adjacent rock.

At the Plaster Bluff, on the Little Missouri, on Sections 29 and 30, Township 8 south, Range 25 west, are valuable beds of gypsum, as exhibited by the following section:

Slope, with ferruginous conglomerate and limonite iron ore,	20	feet.
Plaster stone, either fibrous, or crystallized into selenite,	15 inches to 15	"
Limestone, ...	6	"
Ash-colored marl, ...	67	"
Red clays and green earths, ...	2 to 4	"
Soft, white sandstone, ...	8	"
Red clay, extending nearly to the foot of the bluff, ...	70	"
White sand, where the cattle lick, ...	10 to 15	"

This plaster-bed must become of some practical importance, from the fine quality of the plaster-stone that may be obtained here, and from the associate limestone, both highly useful to the agriculturist as mineral fertilizers.

At the so-called Alum cave, the slates of the millstone grit are contorted in a most remarkable manner, forming one anticlinal and one synclinal in a very short space. Alum is scarce and difficult to obtain here, on account of the abrupt nature of the bank, and there being little or no shelter to protect any saline matters from being washed away.

General Royston's chalybeate spring was tested at the fountain-head, and the principal constituents ascertained to be

Bicarbonate of the protoxide of iron,
Sulphate of soda (Glauber salts),
Trace of carbonate of alkali?

The water rises from under a conglomerate that rests unconformably upon the sandstones of the millstone grit,—the conglomerate being probably of quaternary date. This spring is situated on the east half of the southwest quarter of Section 33, Township 7 south, Range 25 west. It is a saline chalybeate, and possesses good medicinal properties.

Two to three miles southwest of the factory, on the Little Missouri River, the cretaceous limestone is seen to extend some distance up the Muddy fork of that stream. The factory was established by the enterprise of Henry Merrill, three and a half miles north of Murfreesboro, for the sake of the last good water-power on the Little Missouri River, before the waters of that stream leave the disturbed strata of the millstone grit, and enter the more level tracts and superior soils south of this water barrier; relying, however, for support upon the rich plantations south of Murfreesboro. And truly, that gentleman deserves a great deal of credit for what he has already done to advance the interests of this portion of the State.

The cretaceous limestone does not extend much north of Section 4, Township 8 south, Range 26 west, but prevails more along the Muddy fork, where the best agricultural lands are situated.

I examined Holcomb's lead prospect, on Section 7, Township 8 south, Range 26 west, on a branch of Bacon's creek. It resulted in the discovery of some loose particles of lead ore, found strewed along the bed of the creek, and irregularly disseminated in the adjacent cretaceous limestone; but no body of ore of any practical value has yet been found. Fine building stones might be obtained from the stratum of limestone at this locality, in blocks ten inches thick, four to six feet long, by three to four feet wide.

Higher up the creek, the rock is more irregular on the surface, and weathers cellular and rough.

We collected a virgin soil from Section 5, Township 8 south, Range 26 west; over the solid cretaceous limestone and marl; also soils from an old field, thirty to forty years in cultivation, from David Holcomb's farm, on Section 4, Township 8 south, Range 26 west, only a few hundred yards from the virgin soil. The principal growth is white-oak. These soils have been analyzed, and will be found recorded in Dr. Peter's Report, Nos. 372, 373, 374.

On Bacon's creek, on Section 4, Township 8 south, Range 26 west, a fine ash-colored and red gypseous marl, with crystals of selenite, was noticed. Ascending the hill towards the lignite bluff, over the gypseous marl, some fifty or sixty feet of solid cretaceous limestone are observable.

At the lignite bluff on Bacon's creek, on the northwest quarter of Section 8, Township 8 south, Range 26 west, the lignite bed lies at the base of the bluff, and dips under the bed of the stream. The following is a section of this bluff:

Red gravel beds,	5 feet.
White stratum, running into pink,	6 inches to 1 foot.
Pink, calcareous stratum, hard rock above, earthy beneath,	4 to 5 feet.
White sandy, calcareous, and marly stratum,	6 to 8 "
Lignite, partly earthy and partly of good quality,	3 to 4 "

This is very much like part of the section under the gypsum, at the gypsum bluff, on the Little Missouri.

After crossing the Antoine, the country is mostly pine and oak gravelly flats; but off to the south, behind Kelley's house, on Section 30, Township 8 south, Range 23 west, the Exogyra marl bed is well exposed, heavy and thick, in a ridge. This ridge bears north of east and south of west. This marl is a buff-colored earth, with fragments of Exogyra and other fossil shells disseminated. The following is the analysis. The lime and phosphoric acid will necessarily vary in their proportions, depending upon the amount of shells in the earth to be analyzed. In the portion selected for this analysis the earth predominated.

Moisture,	6.20
Insoluble silica and silicic acid,	62.60
Peroxide of iron,	5.20
Carbonate of lime,	22.40
" of magnesia,	0.50
Alumina,	1.20
Chlorine,	0.03
Phosphoric acid,	0.06
Alkalies, mostly soda,	0.04
Organic matter and loss,	1.77
	100.00

After crossing Saline creek, according to the settlers, the cretaceous marls and limestones are found on the higher ground.

About ten miles north of Kelley's the slate formation commences; and the boundary between the slate and sandstone formations is just below Merrill's cotton factory.

The hard shell limestone of the cretaceous formation shows itself frequently in the vicinity of Murfreesboro; but it is mostly covered by a quaternary gravel,—this gravel, in some places, being cemented into a ferruginous conglomerate. There is also a cretaceous limestone at Judge White's, on the north side of Prairie creek, bearing south of west. This limestone was struck in digging a well, and extends two or three miles, being then succeeded by the sandstone and slate. No limestone was observed from the mouth of Prairie creek, on the Little Missouri, to the extreme southeastern limit of this county.

The sandstone and conglomerate at the Simpson Spring were next examined. At one place, the sandstone is burst open and laid on each side of the rent, at an angle of 46° to 48°. In the hill above there is an extensive formation of coarse ferruginous conglomerate, but not of the age of the true millstone grit conglomerate. It is formed by the recementing of the water-worn pebbles formed at the time of the upheaval of the sandstone and slate, which was subsequent to the deposition of the millstone grit. This tilted sandstone is about fifty feet below the top of the adjacent cliff of ferruginous conglomerate. The angle of dip is 64° to the south; the strike line being west 10° south, north 10° east. The ferruginous conglomerate rests unconformably on the tilted sandstone of the millstone grit, or overlying red shales. About one quarter of a mile further south, down a ravine towards the Little Missouri, the sandstone has been broken and tossed into the greatest confusion along a line nearly northwest and southeast, in the same course as the eruption of the porphyritic greenstone below Judge White's. Here there has no doubt been an effort of the igneous rock to reach the surface; but it has only rent, and tilted, and broken up the superincumbent sandstone. Some rusty, irregularly fractured shale, alternates with the sandstone: one bed measured ten and a half feet across the tilted edges. The strike line seems, in some places, to be twisted round towards the northwest. The sandstone extends, in this disturbed, tilted, and confused condition, down to the Little Missouri, at least one quarter of a mile. Everything here denotes violent internal convulsion.

Higher up this ravine, towards the head of Simpson's Spring, there is an oozing of bituminous matter amongst the conglomerate; but it is not enough to be of much value. Under the conglomerate there is a white, sandy clay.

The Simpson Spring is good water, having no mineral taste about it.

The red lands of Pike are towards the head of the Antoine, in Township 6 south, Range 24 west, about the county line, and north of Bear creek Mountain, extending west to the Little Missouri, Muddy River, and the Saline, in Polk County.

The level was measured from the Little Missouri River, at the mouth of Prairie creek, to the top of the sandstone, or rather Chimney Rock, on Section 29, Township 8 south, Range 25 west, and the height ascertained to be eighty-five feet. The sandstone lies in such a state of confusion that it is difficult to tell which way it dips; and the Chimney Rock, which looks like trachyte and felspathic lava, is in the midst,—sandstone flanking it on the south and a little on the north.

The next hill measured is a few hundred yards northeast of the preceding, and is 105 feet above the Little Missouri. It is composed of black, rusty basalt, fracturing into irregularly rounded and cuboidal masses, with some small glistening scales of mica, on the weather surface. This hill is on Section 21, Township 8 south, Range 25 west.

Another hill to the northeast, found to be of the same height, is composed of trachyte, and hard, glistening, metamorphic sandstone.

SECTION XIV.

OUACHITA COUNTY.

Near the boundaries of this and Columbia County, gray and orange sand prevail, alternated in places with red clay. This can be well seen near Smackovert creek. The surface is rolling, growth of timber mostly beech and oak, with some pine. At Widow Bell's, the gray sand is underlaid by red sand and clay.

By a very inefficient mode of cultivation in this region, only eight to ten bushels of corn, and about the same of wheat, have been raised to the acre. By proper tillage, and mixing the beds of sand and clay, the crop might be at least doubled.

A set of soils was collected from the Spanish mulberry lands in this part of Ouachita County. Locality, the orchard of T. C. Meredith, ten or more years in cultivation. On this land they raise one bale of cotton to three acres. It is considered, however, the best upland soil on the farm.

This farm is watered by Cypress creek, and is situated sixteen miles southwest of Camden.

A sample was also collected of the so-called "Ironshot" land, from

Frank Cross's farm, where considerable silicious iron ore exists, with a great deal of ironstone and gravel.

This red "Ironshot" land produces from 800 to 1000 pounds of cotton to the acre. The sample collected, though close to the surface, may be considered more of the character of a subsoil than of the nature of those usually obtained from the surface of a cultivated field.

Beyond Cross's this "Ironshot" land is covered by loose white sand.

The gray sandy land, with a prevalence of black walnut timber, is considered to produce best in this country, except in rainy seasons, when the red lands will yield double as much. On an average, the gray sandy lands produce from 500 to 800 pounds of cotton to the acre.

No limestones or marls are known in this part of Ouachita County.

Six miles from Camden we find the following succession:

Gray sand,
Orange-colored sand and clay,
Ash-colored sand and clay.

Both the gray and orange sand are occasionally indurated into ferruginous sandstone; and, at different localities, all the intermediate stages were seen.

Four miles from Camden the underlying ash-colored sand and clay appear from 30 to 35 feet above Two-bayou bottom. The top of the red sand and clay in sight of Camden is 110 feet above the level of Two-bayou.

The lignite, at the drift of the Camden coal mine, on Section 12, Township 12 south, Range 18 west, is 50 feet above high water of Ouachita River. The lignite is seen at the mouth $5\frac{1}{2}$ feet thick; but at least 6 inches lie below the surface, making 6 feet in all. The following is a section:

Sand and ferruginous sandstone,	20 to 30 feet.
Ash-colored clay,	6 to 7 "
Lignite,	6 "
Pipe-clay, with segregations of limonite ore,	10 to 18 "
Light-gray sandy clay, somewhat ferruginous,	

This lignite has a rather rhomboidal cleavage; can be cut with a knife; and receives a good polish, which gives it a much blacker appearance. It is solid, heavy, compact, of a bluish-brown color, disintegrating, however, by exposure to the atmosphere. The following is an approximate analysis of this lignite:

Dried at 260°.		Moisture,	32.00
Volatile matter,	60.5	Volatile gas,	28.50
Coke,	39.5	Fixed carbon,	34.50
		Ashes,	5 00
	100.0		100.00

White sand, below the lignite, shows itself in the hills adjacent to the Ouachita, for some five miles above Col. Nolan's, rising sometimes fifty feet above high water, somewhat conformably with the curve or outline of the hill. There has evidently been considerable disturbance of the strata to throw up these swelling and dome shaped hills, which are from 100 to 200 feet in height.

This is probably the same bed of coal which sinks under the bed of the Ouachita above the mouth of the Little Missouri.

The lignite* is not everywhere as thick as at the Camden Coal Company opening. It averages, as far as has been ascertained, from three feet to six feet two inches. It is overlaid by a light-colored, almost white claystone or shale, that runs into a brown or gray clay as it approaches the coal. The immediate underlying layer is a dark-brownish shale, with vegetable remains, but ill-defined, running downwards into a white tenacious clay, with segregations of good limonite iron ore. The following is an analysis of this limonite:

Water,	4.50
Insoluble silicates,	27.38
Peroxide of iron,	51.88
Alumina,	3.90
Sulphate of lime,	4.60
Sulphate of magnesia,	0.61
Carbonate of alkalies,	2.25
Sulphur,	3.90
Loss,	0.98
	100.00

This ore contains too much sulphur to produce good iron.

The material under this limonite iron ore, seems to be a very fine light-gray, silicious clay.

* This lignite was distilled in a small iron crucible, to which a glass receiver was attached and kept cool with water. The first product that came over was gas having a feeble odor of sulphurous acid and burning with a tolerably bright flame. The gas was soon accompanied by ammoniacal water, a yellowish oil, and a waxy product,—the latter rising into the exit pipe of the glass receiver whenever the fire was a little too strong, which proves it to be very volatile; but when condensed, it has the consistency of lard and the color of beeswax. The last products which came over were lubricating oil and paraffine. Statement:

3700 grains of lignite gave:

	Grains.	
Coke,	1400=in per cent.,	37.83
Watery solution, containing sulphurous acid, organic acids and ammonia,	1270	34.32
Crude oil,	450	12.16
Gas and loss,	580	15.69
	3700	100.00

From this analysis 2000 pounds of lignite would yield 35.40 gallons of crude oil.

Occasionally small segregations are found in the lignite, approaching amber and retin-asphaltum; in fact, much of the coal has a retin-asphaltum aspect.

The Camden Coal Mining Company have upwards of 2900 acres; and the Union Coal Company, 200 acres north of the Camden coal. The latter are now erecting an oil manufactory for the distillation of the oil from the lignite. According to the report of a chemist in New Orleans, who tested this coal, the most oil obtained was twenty-nine gallons; but Mr. Brittan, the superintendent, thinks it will not average more than twenty gallons to the ton. The upper part, underneath the shaly layers on the very top, is the richest in oil.

It is expected that, on account of its disintegrating property, there will be little expense in preparing it for the retort; and, on account of the large percentage of paraffine and benzole, it will pay as well as the Cannel coal, which yields a large percentage of oil. This, however, remains to be proved by future practical operations.

We collected a sample of virgin Ouachita bottom land, from Section 30, Township 12 south, Range 18 west; growth white-oak, water-oak, large pines, beech, hickory, dogwood, and ash; undergrowth, cane, and yellow bass-wood. This soil was analyzed, and will be found recorded in Dr. Peter's Report, No. 378.

This land is best for cotton, producing one bale to the acre. There are forty to fifty bushels of corn raised to the acre. Col. T. J. Nolan's farm, from which this soil was taken, comprises 3000 acres, of which 1000 are considered coal land; that is, underlaid by the lignite, three to six feet in thickness. The lignite on the bed of the Ouachita, above the mouth of the Little Missouri, is said not to be as good as on Col. Nolan's land. The ore of Pike County, near Henry Davie's, is, no doubt, the same kind of ore seen near by, and associated with the lignite on Section 12, Township 12 south, Range 18 west, on the ridge, one and a half to two miles from Col. Nolan's house.

The red lands in Ouachita County are on Dr. Burford's, Mr. Carr's, and Widow Oreille's places, in the vicinity of the Union Church; at the Foster post-office, six miles from Camden; also at Smith and Hawkins's place, three to three and a half miles west of Camden, on the Washington road. The red land at Smith and Hawkins's place, resembles that at the Foster post-office; but the latter is the best producing land of the kind to be found in the county.

Portions of the ferruginous sandstone and conglomerate, found abundantly around Camden, and in the Ouachita hills near the lignite mines, afford tolerable iron; though that in the sand is generally too silicious; in the clay it is generally good.

At John Work's, three miles west of Camden, in digging a well, they passed through the following section:

Surface sand,	
Tenacious, sticky clay, ...	3 feet.
Softer yellow clay, ...	3 "
Black, alum earth, solid, and cutting like putty, ...	15 to 20 feet.

The following are the principal constituents of John Work's alum spring:

Acid sulphate of alumina (and perhaps potash), but the acid reaction of the water rather indicates the more feeble base, alumina.
A sulphate of the protoxide of iron.
Traces of sulphate of magnesia and lime.

The medical properties are astringent. This water should be used with great caution.

Camden is situated on the orange-colored sand, underlying red clay. The water is not good; there should be cisterns. The orange-colored sand and clay are forty to fifty feet thick in the neighborhood of Camden.

After crossing the Ouachita River, we passed over two miles of Ouachita bottom land; then over flat, pine lands of rather a wet character, to within a mile or two of Dr. Burford's, where the soil is more sandy. These lands are but little elevated above the Ouachita bottom.

The pipe-clay lands in Dr. Rumph's neighborhood, are in the same township as that on which we encamped at Dr. Burford's, being only two miles west. Dr. Burford lives on Section 16, Township 12 south, Range 16 west. The soil here, runs into a light, porous mass; and under the gray sand, is a red, sandy clay.

The pipe-clay soil is usually known by the name of "The Flat," as the water stands on it in the spring. It needs draining, the application of lime, and probably of phosphoric acid. In a dry season, it will average 1200 pounds of cotton to the acre, and will double the amount of the upland, sandy soil, near Dr. Burford's. In a wet season, it does not afford a good stand of cotton, nor will it even produce good corn.

After leaving Dr. Burford's we passed over two to three miles of flat, sandy soil; but the sand is evidently superficial, and based on clay, from the amount of standing water seen after a heavy rain. At the causeway, on the northeast side of the toll-gate, we observed sandy clay with fine white gravel thrown up on the levee. These strata are most probably the same which overlie the lignite.

At the end of the causeway, we ascended a few feet to the level pine

and oak lands, composed of a darker and deeper sand mixed with fine gravel. This is probably the base of the orange-colored sand.

The gravel increases the further we go northeast towards the Freeo post-office, and the sand becomes redder. From a well on the road, a material of coarse gravel has been thrown out. Though the soil along the road is very gravelly, there is a good farm about two miles southwest of Freeo. We did not see any more good farms in this neighborhood. Near Freeo we observed gravel resting on red clay; the road also was strewed with gravel.

After turning off towards the Calhoun line, the country becomes level, and the growth is pine and oak. Here there is not much gravel, nor is the sand deep. We, however, ascended to gravel about one a half miles from the forks of the road.

In digging a well in the northeast part of Ouachita, near Freeo, the following succession was obtained:

Gravel, sand, and clay,
White sand,
Streaks of pipe-clay.

No lignite has been found, so far as I have ascertained. The soil in the northeast is mostly gray and bluish-gray sand, with local gravel.

On approaching the Calhoun line, we struck the Camden road twenty miles from Camden, and observed dark sand and gravel, with a growth of pine and oak. There are no black, cretaceous lands, in Ouachita.

A bed of lignite dirt was seen at low water line on the south bank of the Ouachita, at Miller's bluff. The following is the section:

Gray and ferruginous sandy soil, with ferruginous "ironshot" gravel and soft ferruginous sandstone, ...	10 to 20 feet.
Orange sand, ferruginous clay, and iron gravel, . . .	5 to 10 "
Ferruginous, gray, and yellow sand, with an irregular one foot band of gravel in yellow sand, ...	75 "
Soft, brownish-yellow, ferruginous sandy clay, ...	42 "
Lignite dirt, low water level.	

For two or three miles, the red clay shows itself almost to the top of the ridges on the road.

SECTION XV.

LAFAYETTE COUNTY.

No limestone, either of cretaceous or tertiary date, was seen in this county. The ridges and hills which lie between the numerous water-courses attain an elevation of 100 to 130 feet, and are for the most part composed of

White and gray sand,	Ferruginous sand, conglomerate and sandy iron ore,
Orange-colored sand,	White silicious pipe-clay.

These, alternating with red clay (sometimes used as paint) and with gravel, give character to a variety of upland soil, which will yield from 800 to 1000 pounds of cotton per acre.

No lignite has yet been found in Lafayette County; but in the south-eastern parts the place of the lignite seems to be indicated by a black dirt, which has an offensive odor, probably caused by sulphuretted hydrogen or some carburet of hydrogen generated by the action of iron pyrites on organic matter.

The prairies in the northern part of the county have a black sandy soil. This is also the character of the greater portion of the Red River bottom known as the "black sand land." On the east side of Red River, in the southern part of the county, there is a peculiar country known as "Hog-wallow land."

For the chemical constituents of the genuine "black sand land," as collected at Col. A. D. Foulke's, on Red River bottom, see Dr. Robert Peter's Report, Nos. 354, 355, 356; and for the analysis of genuine red or chocolate-colored, stiff cane and cotton Red River bottom land, as collected at S. Crenshaw's, from timbered land on the edge of Lost Prairie, Township 14 south, Range 26 west, see Nos. 357, 358, 359, of the same Report.

COLUMBIA COUNTY.

In the western part of Columbia County, on the oak flats of Bayou Dorcheat, the soil is a silicious clay, bordered by sandy land elevated a few feet above high water; at a still higher level, the sand and gravel beds alternate with dark sands and red silicious clay.

At a large cotton plantation adjoining Dr. Smith's, ten miles west of Magnolia, a red silicious subsoil was collected for analysis. This land is reported to produce from 1000 to 1500 pounds of cotton to the acre.

A well dug at Dr. Smith's showed the following section:

Soiled sand,	
Red clay,	4 to 6 feet.
Jointed clay,	4 to 5 "
Red sand, where water was obtained.	

The southern part of Columbia County is for the most part sand and gravel land, with some Spanish mulberry land. On King's creek the country is generally a level black sand land. In the vicinity of Atlanta the general character of the soil is sandy, averaging 1000 pounds of cotton to the acre. On Big creek flats the soil is a white clay, and the growth holly, beech, and pine. This soil has not been much cultivated until lately.

Soil and subsoil were collected from McClerken's plantation in the northeast part of the county, comprising red clay and gravel land on which oak and pine is the principal growth.

A qualitative chemical examination of J. V. Butler's mineral spring, two miles northeast of Magnolia, furnished the following result:

Temperature of the air 43°; of the water 63°.
Bicarbonate of iron held in solution by some organic acid.
A small quantity of chloride of sodium (common salt).

It is a saline chalybeate, with medical properties,—tonic, slightly alterative, and laxative.

The geological features of Columbia County, like those of Lafayette, result from the variable material, sand, clay and gravel, found at the junction of the quaternary and tertiary formations.

No lignite, limestone or shell marl has been found in this county; but the place of the former has been indicated in several situations by black dirt struck in digging wells.

UNION COUNTY.

In the northern part of Union County, in the vicinity of E. Rieve's, the orange-colored sand underlies a sandy soil and has a thickness of 40 feet.

On the hill adjoining Widow Anderson's house, at the base of red clay and gravel we found a large amount of silicified wood, singularly petrified.

In digging wells at Mrs. Anderson's, some shallow, others sixty feet deep, they passed through

Orange-colored sand, Red clay and gravel.

According to Major Coulter, there are three main varieties of soil in this county:

1st. Yellow silicious soil, on which the principal growth is beech, oak, gum, holly, pine, maple, and ironwood, with an undergrowth of hazel. This is the most productive soil in the county and prevails in the northwestern and southeastern parts.

2d. Light sandy land, which occupies a belt in the centre of the county, the line running from northeast to southwest a little south of Lisbon.

3d. White crawfish clay land, flat pine, or glady pine land.

Samples of the first soil were collected from Major D. K. Coulter's plantation near Lisbon, on the waters of Camp creek, yielding on an average eight hundred pounds of cotton, twenty bushels of corn, or ten bushels of wheat to the acre. For the analysis of this soil, see Dr. Robert Peter's Report, Nos. 348, 349, 350.

The second quality of soil was collected near the old Methodist Church, in Eldorado. It is a light sandy soil based on the orange-colored sand and clay just above the gravel. It will produce on an average from six hundred to eight hundred pounds of cotton, or fifteen to twenty-five bushels of corn to the acre.

Samples of the third quality of soil were collected from the glady pine flats on Camp creek, Section 2, Township 17 south, Range 17 west. This soil is not much cultivated, and is generally considered worthless. See No. 40, in Dr. Peter's Report.

There is no genuine red land in this county; but there are some small tracts of chocolate or mulatto-colored soil.

In the vicinity of Eldorado the country becomes more broken, and the orange-sand and clay which underlie the No. 2 soil has a thickness of forty or fifty feet.

Two miles north of New London we saw the following section:

Soil and gray sand,
Subsoil, grayish-white jointed clay,
Orange-sand and red clay, with some gravel near the base,
Dark sandy clay, or black dirt,
Lignite,
Pipe-clay.

Three and a half miles south of Eldorado we observed a considerable amount of silicious iron ore, but too sandy for manufacturing purposes.

We collected soils from Mr. Cole's land, Section 22, Township 18 south, Range 14 west, three miles northwest of Hillsboro. This is called swamp bottom soil, and is supposed to be different from the Camp creek pine-flat land; but looks very much like it.

A qualitative examination of N. Bussey's mineral spring, southwest of Eldorado, gave, as the principal constituents:

Bicarbonate of the protoxide of iron,
Crenate, or appocrenate of iron,
Chloride of sodium (common salt).

It is a saline chalybeate. Its medical properties are, tonic, slightly laxative, and alterative.

A fine sample of silicified wood was found at our camp on Mr. Daniel's land near Hillsboro.

We collected a sample of loamy clay for analysis from the creek bottom, four miles northeast of Hillsboro, on the Wilmington road, where ferruginous sandstone, silicious iron ore, and silicified wood are found. This is about ninety-five feet below the average summits of the adjoining ridges.

At Henry Bailey's they are working a bed of lignite thirty inches thick, with brown shale six inches: in all three feet.

An impure earthy lignite has been struck in several wells near the line between Townships 18 and 19 south, Range 13 west. There is also some lignite at Wilmington.

At Rucker's, five and a half miles from Moro, under a spring, lignite clay shows itself some fifteen or twenty feet below the general surface of the country, penetrated by the roots of a chestnut tree which grows above the spring. It is too impure, where exposed, to be of the least value.

Three miles from Moro ferry, at Mr. Markham's, an impure lignite, three feet thick, was passed through in sinking a well. The materials above the lignite were, for the most part, coarse sandy loam with streaks of yellow ochre.

No good water can be found in this part of the country on account of the contamination of the lignite. In fact, the whole country around the forks of the Ouachita and Saline rivers is underlaid with lignite. It shows itself between high and low water mark in the bank of the Ouachita between Moro and Pigeon Hill; again eight or ten miles below Moro, and six or eight miles below Pigeon Hill; it is also seen near low water mark on the northeast side of the river, in the swamp land district of Calhoun.

CALHOUN COUNTY.

The principal red lands of this county commence at Moses Johnson's, eight miles north of Hampton, and extend to James Rigg's, within two and a half miles of Hampton.

On Moro River the soil is of a rich chocolate color, with some red sand and loam.

The following section is taken from a well at A. W. Thomas's, in the northern part of the county:

Soil, gray sand,
Subsoil, sandy clay or red ferruginous clay, sometimes with gravel, about . . . . 10 feet.
White sand, ... 8 to 10 "
Pipe-clay or sand, with segregations of clay,
Black dirt, with fragments of leaves,
Lignite.

Water is generally obtained in the white sand of the above section where it is underlaid with stiff clay; but when the clay, as is sometimes the case, runs into sand, then it is necessary to go down to the lignite bed for water.

We saw large quantities of silicified wood at Mr. Thomas's store; one log measured thirty feet in length. Layers of ferruginous sandstone and of a soft gray sandstone, which hardens by exposure to the air, were also observed.

The following is a qualitative chemical examination of Dr. W. A. Thomas's mineral spring on Beaver pond branch of Freeo. It is slightly alkaline to litmus paper, and contains:

Bicarbonate of the protoxide of iron,
Chloride of sodium,
A trace of magnesia.

It is a saline chalybeate, with slightly tonic and laxative properties.

The double mineral spring of J. I. Holdernis, on Section 4, Township 11 south, Range 14 west, was also examined. It is a pure soft water, boiling up from under the gravel in red sand.

In the vicinity of Chambersville the country is rolling. We observed the following section in a hill thirty-five feet high:

Gray sand,
Orange sand and gravel,
White sand,—in all 35 feet.

The white sand is seldom seen except in low places, and the whole thickness of the strata does not exceed fifty feet.

Silicified wood was found near Chambersville. We collected from R. Atkinson's land, Section 22, Township 12 south, Range 13 west, a real soil of gray sand land, with a subsoil of red clay, which enables it to withstand the drought. The growth is principally white oak, red oak, post oak, and pine; with an undergrowth of chincapin. This soil will yield from 800 to 1000 pounds of cotton per acre.

At Mr. Atkinson's spring there is a very soft gray sandstone and some ferruginous conglomerate.

Ten miles north of Hampton we passed over a ridge 140 feet high, covered with gravel. This gravel forms the surface stratum to within three miles of Hampton, with occasional beds of sandstone, ferruginous conglomerate, and sandy iron ore. Around Hampton the surface is level and there are some good plantations.

In digging a well on William Thompson's place, one mile south of Hampton, they passed through:

Clay,	Pipe clay, one foot thick,
Gravel, with streaks of red clay,	Black dirt and lignite,—in all, 23 feet.

In the southern and western parts of Calhoun the soil is mostly sandy. East of Campagnole creek the land is low and flat and the soil is sandy but contains more clay than the land on the west side of the creek, in some places being inclined to be crawfishy and spouty.

The soils of this county have not yet been analyzed.

BRADLEY COUNTY.

In the southern part of Bradley County a light-gray silicious soil mixed with some gravel seems to prevail, with occasional patches of ferruginous conglomerate of tertiary date. When cultivated this land will produce from 800 to 1000 pounds of cotton, or 30 bushels of corn to the acre. On what is called the "second bottom" or "hummock land" there are many ancient mounds, with local beds of fresh-water shells, mostly Unionidæ, collected together no doubt by the Indians who formerly inhabited this region, to whom these animals served as food.

Samples of the above mentioned soil were collected, for analysis, from Col. J. R. Hampton's plantation. It yields from 1000 to 1500 pounds of cotton, or from 30 to 35 bushels of corn to the acre. The principal growth is hickory, pine, and oak; the undergrowth is witch-hazel and sumac. The low bottom land is a white clay, cold, wet and slushy, with an abundant growth of palmetto. This soil is very white, and is therefore used as a substitute for lime in whitewashing. Samples of this also for analysis were collected at Col. Hampton's.

Lignite is found at many places in this part of the county. Nine miles from Col. Hampton's, in the edge of Calhoun, there is an exposure of lignite in the bed of Saline River at Goulett Island, belonging to Governor E. N. Conway. It extends entirely across the stream, forming a partial dam, over which the water falls with considerable noise. At the time of my visit this bed was under water, and I learned from Antoine Foyle that it was six or seven feet thick, compact, and of a black color; and that it is mined in large blocks, which burn well in a fireplace and make a hot fire.

The lignite on the Saline, in Section 34, Township 14 south, Range 9 west, at the sulphur spring belonging to J. H. Crawford, is said to be over six feet thick. I was unable to obtain myself a measurement upon it. The quality is the same as that on Governor Conway's land. The specimens collected were examined for oil in my laboratory, and gave from 200 grammes, distilled in a small iron crucible, as follows:

	Grammes.	Per cent.
Coke,	79.35	39.675
Ammoniacal liquor,	56.15	28.075
Crude oil,	36.00	18.000
Illuminating gas and loss,	28.50	14.250
	200.00	100.000

According to this analysis there are 45 gallons of crude oil in 2000 pounds of lignite. The practicability of manufacturing oil from this variety of coal has already been alluded to in the first part of this Report.

A qualitative chemical examination of Mr. Crawford's sulphur spring, shows it to be a strong alkaline sulphuret water, alkaline to test paper. The principal constituents are:

Carbonate of alkalies, probably both soda and potash,
Sulphuret of alkalies,
Sulphate of magnesia (Epsom salts),
Chloride of sodium (common salt).

This water no doubt also contains silica, for a log of wood in it is partially petrified. Its medical properties are antacid and antiscorbutic.

Sulphuretted hydrogen was quite perceptible as odor in this water, but could not be detected with the usual lead and silver reagents. Yet there is reason to believe that it may exist, in combination with organic acids, in a state not affected by salts of lead or silver.

The high bottom land of the Saline at James Crawford's is less sandy, and more argillaceous than the "hummock land," and will sometimes produce a bale of cotton to the acre, or from thirty to thirty-five bushels of corn.

In the vicinity of Warren the soils are of a light-chocolate color, underlaid by red clay. Specimens were collected from E. S. Franklin's plantation for chemical analysis. See Dr. Robert Peter's Report, Nos. 369, 370, 371. The principal growth is post-oak, black-oak, and pine, with an undergrowth of dogwood, maple, and hazel. It will produce eight hundred pounds of cotton, from twenty-five to thirty bushels of corn, or from fifteen to twenty bushels of wheat to the acre.

In the northwestern part of Bradley a set of soils was collected from

J. H. Mark's plantation, northeast quarter Section 4, Township 11 south, Range 11 west, called a "genuine red soil;" the characteristic growth is elm, mulberry, prickly ash, red-oak, and a few white oaks and hickory; the undergrowth is dogwood, muscadine, and other grape-vines in great abundance. The average yield is eight hundred pounds of cotton, forty bushels of corn, or fifteen bushels of wheat; it is also good for rye and oats. Subsoiling improves this land. See Dr. Robert Peter's Report, Nos. 375, 376, 377.

A large quantity of tertiary iron ore, containing casts of fossil shells, was seen in the northwestern part of the county, especially on J. M. Mark's land, Section 4 and Sections 17, 18, 19, Township 11 south, Range 11 west; also on Warren Crain's, and William Boyd's land. The highest part of Mark's field is covered with tons of this fossiliferous iron ore. It was reported by Mr. Boyd that specimens had been sent to Philadelphia for examination, and word returned that it contained copper, silver, and platinum. There must be some mistake about this, as I have not been able to detect any trace of these metals in the specimens collected.

Gypsum, gypseous marl, and tertiary shell marl are also found in the northwestern part of this county. There has not yet been time to make an analysis of these marls; but there can be no doubt that they will prove highly important as mineral fertilizers for certain kinds of land.

On Section 4, Township 11 south, Range 11 west, we observed the following section:

Light sandy soil,	4 inches.
Stiff yellow clay, with a streak of white,	3 feet.
Greenish-gray marl,	1 foot.
Brown oxide of iron, fossiliferous,	5 inches.
Calcareous sand-rock, usually a hard greenish shell-rock, with protoxide of iron,	10 feet.
Black dirt,	18 feet.
Lignite,	
Blue clay, with some sand,	
Water-bed.	

The following is a qualitative chemical examination of mineral water, on Section 16, Township 12 south, Range 10 west:

Trace of carbonate of iron,
Crenate and appocrenate of iron,
Trace of sulphate of magnesia,
Trace of sulphate of soda,
Trace of chloride of sodium.

Its medical properties are tonic and slightly laxative.

The water which supplies J. M. Mark's steam boiler rises through a peculiar white, gray, and greenish marl, which would no doubt prove a good fertilizer, and samples were collected for analysis. This is a strong

alkaline, saline water, with a trace of free sulphuretted hydrogen, and sulphuret of alkalies. The principal constituents are:

Carbonate of alkali,	Chloride of sodium (common salt),
Carbonate of lime,	Sulphate of magnesia (Epsom salts),
Carbonate of magnesia,	Sulphate of soda (Glauber salts).

The well of water at J. L. Murphy's, on the west corner of Section 24, Township 12 south, Range 10 west, afforded:

Chloride of sodium, strong,	Carbonate of magnesia,
Sulphate of lime,	" soda,
" magnesia,	" potash.?
Carbonate of lime,	

Its medical properties are tonic and antacid.

Leag's mineral water is six miles from Warren. Of several springs examined the strongest gave:

Sulphate of magnesia (Epsom salts),	Carbonate of magnesia,
" soda (Glauber salts),	" soda (a trace),
Chloride of sodium (common salt),	" potash.
Carbonate of lime,	

DREW COUNTY.

The western part of Drew County is generally level, the highest land being 140 feet (by the aneroid barometer) above the bed of Saline River. No good sections could be seen, and the wells are only 10 to 12 feet deep, passing, for the most part, through—

Soil,	1 foot.
Yellow clay and gravel,	4 to 5 feet.
White sand and gravel,	7 "
Water bed,	
Stiff argillaceous clay ("joint clay").	

The soil is more or less gravelly and the principal growth is pine. A sample of uncultivated soil for analysis was collected from a creek bottom at Robert Grier's, where the growth was gum, red-oak, and post-oak.

J. O'Neal, residing six or eight miles northeast of Lacy, has the largest cotton plantation in that part of the country. The soil is a sandy loam, with a yellow silicious clay subsoil, producing 1000 pounds of cotton to the acre.

In digging wells in the southern part of the county they pass through a kind of rotten limestone. I saw none exposed along our route, nor could I see or hear of any "black dirt."

Five miles to the east of Vazy's, in the oak lands, at Dr. Twitty's and Husking's, there is "black dirt" containing fossil leaves and shells.

A set of soils was collected from James Vazy's plantation, Section 4, Township 14 south, Range 8 west, on the waters of Clear creek. This is average soil of the southern part of the county; the growth being pine, hickory and black oak; the yield, 800 pounds of cotton, or 25 bushels of corn to the acre.

Near our camp at A. Wilson's, there is some ferruginous conglomerate; also a spring of good water.

The ridges in the vicinity of Lacy are about 65 feet above the level of the bottoms, and are composed of red and yellow clay and gravel. Near the Ashley line an impure lignite was struck in a well at a depth of 20 feet from the surface.

In the vicinity of Monticello the country is rolling and the surface more or less gravelly, with a growth of oak and pine. A soil was collected two and a half miles from this place from the "red-oak land" in oak woods; the subsoil is a yellow and red clay, which shows itself along the road.

As the ground was covered with snow at the period of our visit to this region it was difficult to distinguish the geological structure beneath.

An Artesian well, sunk in the public square at Monticello, 150 to 160 feet deep, passed through—

Soil and subsoil,	} 20 feet.
Yellow clay,	
Red clay and a little sand,	
"Black dirt," a dark sticky clay, with segregations,	140 "

At 145 feet depth fossil shells were found. Around Monticello water is generally obtained at a depth of 20 feet in the "black dirt;" but it is not reliable, giving out in a dry time. Twenty miles to the southeast good lasting water is obtained at a depth of from 50 to 60 feet.

Long prairie, ten to twelve miles south of Monticello, is partly cultivated. Lawyer's prairie, twenty-three miles to the northeast, is surrounded by fine large oak timber, and is considered the most productive prairie land in the county.

On Bayou Bartholomew the bottom is from three to six miles wide; the principal growth being gum and white-oak. The gum lands are considered the best and will produce a bale of cotton to the acre.

ASHLEY COUNTY.

Ashley County, north of Fountain Hill, is much the same kind of country and soil as are noted in Drew County; being principally pine on the highlands and oak on the creek bottoms.

Wells sunk at Fountain Hill reach water at a depth of 18 feet, passing through soil, subsoil, stiff red clay with some gravel, and white sand and gravel, in which the water is found.

At Lewis Gardner's a well was sunk 28 feet deep, and the water found in a white sand and gravel one and a half feet above the "black dirt."

South of Fountain Hill the country attains some thirty feet more elevation, with a scattered growth of oak, known as "oak openings." These "oak openings" skirt the prairies of Ashley County and are, like the prairies, interspersed with small mound-like elevations composed of materials which have for a greater time resisted denudation. Soils for analysis were collected from the "oak openings" near the prairies, five and a half miles north of Hamburg. It is a close-textured silicious clay, similar to that found in the post-oak flats of Indiana and Kentucky.

At Hamburg the strata have so thickened as to require wells to be 70 feet deep in order to secure a permanent supply of water.

The lands around Hamburg at the time of the early settlement of the country were wet and boggy, and were reported as swamp lands. Now they are dry, solid, and under good cultivation; showing how great a change may be made by opening the forest, cultivating the soil, and keeping on the farms such stock as by browsing keep down the vegetation and at the same time by treading down the earth render it more compact.

A little south of Hamburg there is a thin seam of lignite which, according to Mr. Pugh, extends westward to the lignite bed on the Saline belonging to Governor Conway.

To the southeast of Hamburg, in the direction of Mr. File's plantation, there are oak openings interspersed with small prairies; both are covered with small mound-like elevations.

Soils for analysis were collected from Mr. File's plantation, Section 2, Township 18 south, Range 7 west. This is considered among the best of the upland soils in the county, and will produce 1000 pounds of cotton, or 25 to 30 bushels of corn, to the acre.

The western part of the county is rolling, and there the soil contains the most gravel. The highest and most broken part is on Beech creek.

The prairies are generally considered worthless for cultivation. That underdraining would render them tillable is evident from the fact, that the low mounds from which the water freely drains are productive. It is

possible that ditches may reach the substratum of sand at a reasonable depth, enabling the water to sink.

Soils for analysis were collected from a prairie between Hamburg and William Spencer's, Section 14, Township 17 south, Range 7 west.

East of the prairies and towards Holly Point there is a ridge of good land on which gum trees are the principal growth.

On Overflowed Creek bottom, which is from a half mile to a mile wide, the land is good, but subject to inundation.

The alluvial bottoms of Bayou Bartholomew are fine cotton lands.

The inclemency of the winter with a fall of sleet and snow prevented anything but a partial examination of this county, as well as of Drew and of Chicot. The soils collected from these counties have not yet been analyzed.*

CHICOT AND DESHA COUNTIES.

At Collin's stage stand, the following section was taken from a well forty-seven feet in depth.

Yellow soil, Subsoil,	2 feet 6 inches.
White pipe-clay,	4 inches.
Firm hard clay, with sand,	12 to 15 feet.
Compact sand, that will stand without curbing,	10 to 15 feet.
Dry loose sand,	15 feet.
Red sand and gravel (water bed),	0

Soils were collected from the "gum swamp land," or "bayou land," as it is variously designated by the residents, at James F. Lowry's, Section 36, Township 13 south, Range 3 west. These are said to be characteristic soils of most of the land between Bayou Bartholomew and Bayou Mason.

* Since Dr. Owen's visit to Ashley County he received a letter from Messrs. W. W. Wood & Son, stating that they had sunk a shaft in search of minerals to the depth of sixty-three feet, and had found copper and other ores resembling silver and lead. Messrs. Wood state, also, that these ores are found in a sandstone, traversed by veins of white quartz, which has a breadth of fifty feet and may be traced fifteen miles in length. The shaft is six miles northwest of Hamburg and ten miles from the Saline River.

According to their statement, they found at the depth of twenty-five feet a bed of coal, or something like it, two feet or more in thickness, full of iron pyrites; but more of the pyrites above and below, than in the coal seam. Beneath this "coal" there were pyritous sands for several feet; then a soft blue rock, three or four feet thick, with "ore" and pyrites in the crevices. Before reaching the depth of sixty-three feet fossil wood was found, which was also charged with pyrites.

With ore taken from this shaft Mr. Wood says he gave a coating of copper to steel.

The fact that sandstones traversed by white quartz and metalliferous veins occur in this county is interesting, and the locality demands a careful investigation.—E. T. Cox.

The "gum ridge land" at Smith's, Stall's, and McDermot's, is blacker and contains more sand than the "bayou soil." In some places it is thin and underlaid by red clay; in others the loamy soil has a depth of eighteen feet, and rests upon blue clay six feet. Under this blue clay is a bed of coarse sand mixed with some gravel, in which good water is reached by digging wells. The bayou or swamp land, at Mr. Lowry's, is low and wet, but admits of easy drainage. It dries up rapidly, and ploughing can be commenced early in the spring. This land is not subject to overflow; it is just beginning to attract attention, and is already worth, adjoining the line of railroad, five dollars per acre. By some of the settlers it is considered more productive than the "gum ridge land" of Bayou Bartholomew.

The land known as the "buckshot land" in this county, is said not to produce as well as the Bayou Bartholomew gum ridges, or the swamp land at Lowry's. It suffers from drought, and produces best in a tolerably wet summer. It is a sticky land, disagreeable to work.

The Mississippi River flows along the eastern boundary of this county, and its broad alluvial bottoms, composed of a rich sandy loam, furnish one of the finest cotton-growing districts in the State.

Desha, as well as Chicot County, has been as yet only partially examined. The land is for the most part flat and subject to overflow during the time of freshets, except where the waters have been restrained by levees.

The Arkansas River, which flows through this county, has been leveed on both banks from Pine Bluff in Jefferson County to the mouth; and the Mississippi River has been leveed thence southward beyond the limits of the State. The land thus reclaimed has become immensely valuable, and in its unimproved state, will sell for ten dollars per acre. Where it lies in large bodies suitable for cultivation, partially improved and not too far from navigation, it commands in the market fifty dollars per acre. Cotton is the principal article cultivated; and from one and a half to two bales can be raised on an acre of the best land.

Soils for analysis were collected from J. B. Johnson's plantation on the Red Fork bayou, and from the vicinity of Napoleon at the mouth of the Arkansas River.

ARKANSAS COUNTY.

The greater portion of Arkansas County between the Arkansas and White River bottoms is prairie land, derived no doubt from the clay bed which underlies the quaternary marl and sands, so well developed in Crowley's ridge, in Phillips and St. Francis counties.

The prairie land is gently rolling, and the valleys are from five to ten

feet lower than the slight ridge-like elevations. They are wet and spouty, and the subsoil when thrown up by crawfish, is a light-colored clay.

Soils characteristic of this prairie land were collected near Col. Farelly's on the Spanish grant. The virgin soil was taken from land owned by James More, Section 18, Township 7 south, Range 3 west, and the cultivated soil and pale yellow ochre subsoil a few yards from the former, on Harold Stilwell's farm, which has been from forty to fifty years in cultivation. For the analysis of these see Dr. Robert Peter's Report, Nos. 406, 407, 408. A virgin soil was also collected from a part of the prairie some four to six feet higher than that from which the above were taken; it is of a more porous quality; No. 409 of Dr. Peter's Report.

The prairie land in this county has generally been looked upon as worthless, in comparison with the woodland which adjoins it, and the alluvial river land. The woodland is said to yield as much as 1800 pounds of cotton, or from 30 to 40 bushels of corn, to the acre. On comparing however the analysis of this soil (No. 410 in Dr. Peter's Report) with that of the prairie soil, it will be seen that the latter possesses as much of the elements requisite for the nourishment of plants as the former. The prairie soil is mainly deficient in lime, soda, potash and organic matter in a soluble condition, as compared with the buckshot soil (No. 411 of Dr. Peter's Report), which contains these elements in an eminent degree.

By a good system of drainage, and the addition of lime in some form, this prairie soil may be made highly productive.* Drainage will loosen the soil, permit the roots of the plant to penetrate to a proper depth, and correct the sour tendency which all standing or superfluous water exerts upon vegetation.

The prairie land comes within one mile of the Arkansas River bank; it is probable that at one time it extended much closer.

Col. Farelly's dwelling-house is built upon a mound 22½ feet above high water. This mound is evidently of aboriginal origin, as the place can be seen from which the earth was taken for its construction; and various human bones and implements of pottery have been obtained from it, showing that it was a burial-place for the dead.

A set of soils, Nos. 1, 2, and 3, was collected from Col. Farelly's and James More's plantation, as specimens of the cotton lands of the Arkansas River bottom. No. 2, the cultivated soil, was collected with special reference to an investigation of the cause of rust in the cotton plant. It was therefore taken from the parts of the field where that had most pre-

* I have but little doubt that a shell marl may be found at a reasonable depth below the level of the prairie, which will serve to furnish lime, as well as other important ingredients to this land. Or a good shell marl may be had at the White Bluff on the Arkansas River, in Jefferson County.—E. T. Cox.

vailed, especially in the year 1857; the object being to ascertain whether rust is owing to the exhaustion of any of the ingredients required for the proper nourishment of the plant, or not. But it appears to be a local disease, only attacking certain plants on a given ground; and as it is worse in some seasons than in others, it is more likely to be attributable to some other cause than to a peculiarity in the proportion of mineral constituents of the soil. The soil is a sandy loam, and the subsoil, at the depth of from one to one and a half feet, is a dark-gray adhesive clay. For the analysis of these soils, see Dr. Robert Peter's Report, Nos. 414, 415, 416.

The following section was obtained at the Post of Arkansas:

Soil,	
Subsoil, a pale ochry clay,	
Under clay, light colored, washed and gullied, containing irregular and rounded pieces of oxide of iron, about the size of a small marble, .	8 feet.
Ironshot clay,	
Compact reddish sand, in which water is usually reached at a total depth of 40 feet, ...	30 "

The latter is of such a compact nature that it cannot be dug with a spade or shovel, but must first be loosened with a pick. It disintegrates readily when exposed to the weather.

The following section was taken from a well dug on Farelly & More's plantation:

Soil,	
Subsoil, pale-yellowish red,	
Under clay, with iron gravel, same as in former section, ...	8 feet.
Compact reddish sand, ...	30 "
Water reached in coarse, white sand.	

A qualitative chemical examination was made of well water at Col. Farelly & More's plantation. It has an alkaline reaction, turning litmus paper blue in a short time. The principal constituents are:

Chloride of sodium (common salt),
Carbonate of soda,
Bicarbonate of lime,
" of magnesia,
Sulphate of magnesia,
" of lime, a trace,
Chloride of magnesium.

Dr. J. S. Loree, of South Bend, in this county, has finally, by a selection from various cotton seeds, succeeded in producing a prolific variety of the cotton plant, which will bear on an average 200 bolls to the stalk; on one stalk he has counted 700 bolls. This is equal to seven pounds of cotton,

taking the usual estimate of 100 bolls to the pound. One plant which we saw, and which Dr. Loree says was planted on the 1st of May, 1859, contained, on the 18th of June, 380 bolls.

JEFFERSON COUNTY.

The soil at Dr. Williams's and that at Dr. De Bow's is of the same character with that last described, varying from a sandy loam to a stiff tenacious red or chocolate-colored soil. The latter is considered the most productive, derived as it is from the fine red sediment brought down by the Arkansas river from the Canadian fork, one of its tributaries rising in the mountains of New Mexico, and flowing through beds of red shale and clay. When floods from this fork raise the Arkansas river, the water grows thick with sediment, as red as blood.

The fertilizing properties of this sediment of the Arkansas river, especially essential to the cotton plant, are manifest from such facts as that stated by Dr. Williams and confirmed by the testimony of others, that on a sand-bar incapable of growing corn, from one to one and a half bales of cotton to the acre have been raised.*

A specimen of the stiff red clay "buckshot land" was collected at Dr. Williams's plantation, the surface soil having rather a chocolate color. For the analysis of soils collected at this place see Dr. Robert Peter's Report, Nos. 426, 427.

At Dr. De Bow's in digging wells they pass through alternate layers of red sand and loam and dark stiff "buckshot clay," and sometimes through several feet of white clay, to a depth of about thirty-three feet, where water is obtained.

Similar strata are also passed in sinking wells on Dr. Williams's plantation. The water is not generally good, and has a fetid odor.

Upon a qualitative examination of Dr. Williams's well water, it was found to have an alkaline reaction. The principal constituents were:

Chloride of sodium (common salt),	Bicarbonate of magnesia,
Carbonate of soda,	Sulphate of magnesia,
" potash,	Protoxide of iron,
Bicarbonate of lime, strong,	Silica.

* Dr. Owen was of opinion, that the fertility of many of the sandy soils of the Arkansas river bottom, was kept up by the river water, which permeated from below, and left its sediment within reach of the rootlets of the cotton plant; and that he intended to speak at large upon this subject is evident from his notes; but their brevity precludes the possibility of my presenting in full his ideas. The roots of the cotton plant, it is said, descend to a depth of from four to seven feet in search of nourishment.—E. T. C.

The habitual use of this water so strongly charged with mineral water must prove injurious to the system.

An analysis of the Arkansas river water at Dr. Williams's landing, the river at low-water stage, gave for the principal constituents:

Chloride of sodium (common salt),	Carbonate of magnesia,
Carbonate of soda,	" potash,
Sulphate of soda (Glauber salts),	Silica,
" magnesia (Epsom salts).	Protoxide of iron.
Carbonate of lime, strong.	

The river water is slightly alkaline to litmus paper, and contains more chloride of sodium than the well water.

At Major J. B. Hall's landing on the Arkansas river we saw the following section, in a space of five or six feet:

Light yellow sand,	Stiff red clay,	Stiff clay, two inches,
Chocolate-colored sand,	Gray sand,	Light yellowish gray sand.

In digging a cistern, Major Hall passed through two layers of clay, which, after the hydraulic cement was put on, had their position marked by an exudation forming a conspicuous belt of a tasteless white crust or powder, probably a hydrate of alumina, which, when dissolved in hydrochloric acid, gives a precipitate of alumina with ammonia, but no precipitate with chloride of barium.

Soil and subsoil were collected from Major J. B. Hall's new plantation, on Section 19, Township 6 south, Range 7 west, known as the oak and sweet-gum land. (See Dr. Peter's Report, Nos. 424, 425.) It differs from the "buckshot land" soil in being lighter colored, more porous, and less tenacious, warmer, inducing a more rapid growth, and when ploughed not forming clods. On a portion of this field there was a remarkable superficial red coating, resembling red land, probably a deposition of alumina and iron, which has been suspended by rain-water.* This light-colored and silicious soil is underlaid by red ferruginous clay. Soils were also collected from J. M. Bass's plantation, of stiff "buck-shot land," an analysis of which is given in Dr. Peter's Report, at Nos. 428, 429. Here was observed more conspicuously than elsewhere the remarkable polish given to this kind of land by the passage of the plough. It glistens in the sun, when turned up, like a metallic or submetallic surface. This peculiar soil receives its name from its crumbling into grains or small irregular balls like buckshot. It is an easy soil to plough if not left until the March winds dry it up and render it so unmanageable that it will not become mellow during the whole season.

Another collection of soils was made from B. F. Richardson's planta-

* The specimen collected has not yet been analyzed.

tion, Section 2, Township 6 south, Range 3 west, where the surface has a superficial coating of reddish and yellowish ochre, and where, especially in low places, the rust prevails.*

In a well dug on B. F. Richardson's plantation the following strata were passed through:

Sandy loam,	4 feet.
Red under clay,	10 to 12 "
Stiff reddish blue tenacious clay,	4 "

* Dr. D. D. Owen makes reference in his notes to a letter on the cotton rust, received from Mr. B. F. Richardson last August; and there is reason to believe that he would have had much to say upon this subject in this report, that would have proved of importance to the cotton planter. The writer does not find any conclusions arrived at in the notes, and will, therefore, briefly give his own opinion from the evidence which has been therein collected together.

From Mr. Richardson's very interesting letter, showing him to be a patient and accurate observer, we learn the following facts:

1st. Rust is a disease of the prolific varieties of cotton.

2d. Where the alluvium, or sandy loam soil, is not underlaid by a tenacious clay (secondary formation of Mr. Richardson's letter), but extends down to the sand, rust is never seen.

3d. The less the depth of soil above the substratum of tenacious clay, the more the plants are diseased.

4th. The disease is most prevalent in the low places where the under clay is nearest to the surface.

5th. Stable and straw manure are highly injurious; whereas a dressing of cotton seed is beneficial.

6th. New ground is as bad for rust as old, or even worse.

7th. From one to one and a half bales of cotton to the acre may be raised on sand-bars formed in the Arkansas River.

We also learn from Dr. R. Peter's Report of the analysis of soils collected from plantations where the rust prevails, that there are no mineral constituents found therein which are in themselves injurious to the cotton plant; see his Report, Nos. 414, 415, 416. These analyses go to show that the subsoil, so far from being an injurious material, is on the contrary rich in elements of fertility.

The inference, therefore, which I draw from the foregoing is, that the natural soil for the cotton plant is a *sandy loam;* that the prolific varieties of cotton necessarily require a greater amount of nourishment than the unprolific or Petite Gulf variety, and send their roots to a greater depth in search of the requisite nourishment (four to seven feet, according to Dr. Williams), at which depth they come in contact with a cold and wet retentive clay, not deficient in wholesome food, but rendered poisonous by an excess of water which has found a lodgment in it.

In this unnatural and sickly condition of the plant the application of manures containing food in a state easily dissolved and readily taken up by the plant, is but adding fuel to the fire; for the enfeebled plant is not able to elaborate with sufficient rapidity this abundant supply of liquid nutriment, and the disease extends itself.

The only remedy, if this be the true cause of the rust disease, will be found in thorough draining; or in properly ditching the diseased land, so as to draw off the water from the substratum of clay. The experiment is easily made on a small scale, and the trial is earnestly recommended to planters whose crops suffer from this blight.

The light-colored "ironshot clay" (417 of Dr. R. Peter's Report), seen at the Post of Arkansas, at Col. Farelly's and More's, and on portions of the prairie land, has always proved to be a wet, crawfishy soil, wherever I have examined it.—E. T. C.

At twenty-one feet depth good soft water was found, which is said to wash nearly as well as rain-water. A well was examined at Major J. B. Hall's, that does not rise and fall with the river, as is usually the case with wells in that part of the country. It contains:

Bicarbonate of lime,	Sulphate of magnesia, a trace,
of magnesia,	" of soda, "
Chloride of sodium, a trace,	Carbonate of soda, "

Major Hall's well-water does not contain as much salt, or carbonate of soda, as the Arkansas River water at the time of examination, nor as much as the well-water on Dr. Williams's plantation.

On the Hon. Robert Johnson's plantation, five miles below Pine Bluff, soils were also collected, some from those portions of the plantation where the cotton is affected by the rust. These, as well as other soils collected in this county, have not yet been analyzed.

The following section was obtained at Pine Bluff:

Fine silicious loam, ...	8 inches to 1 foot.
Ash-colored and light-yellowish gray loamy clay, with some gravel scattered through it, ...	16 feet.
Red clay, ...	16 "
Orange-colored sand and some ferruginous sandstone and yellowish-gray sand, ...	26 "

At Newton's stage stand a fine bold spring, known as the Rock Spring, breaks out from under a bed of gravel, and is nearly as pure as rain water, containing hardly any ingredient but carbonic acid, and apparently a trace of iron. This is the purest and best water for constant domestic use which we have tested in Jefferson County.

Section at White Bluff:

Soil, Sand and clay, Gravel, ...	10 feet.
Thin-banded light-gray clay, alternating with sand, . . .	10 "
Green marly clay, with fossils, underlaid by light and dark-colored marls, highly fossiliferous, ...	60 "

The fossils found in the above section (some of which are figured on Plate IX, accompanying this Report) belong to the Eocene Tertiary.

CRITTENDEN, MISSISSIPPI, AND CRAIGHEAD COUNTIES.

The first two of these counties are, for the most part, composed of alluvial lands, subject to inundation at high freshets of the Mississippi River, which washes their eastern boundary, and of the St. Francis and Little Rivers,

D.D. Owen del.

Lith. by A Hoen & Co. Balto.

SUNK LANDS LOOKING NORTH FROM THE DEEP LANDING.

which flow along their western margin. They have many small lakes and bayous interspersed through the interior; and one of these lakes in Crittenden County, called Blackfish lake, is said to have the bottom paved with brick, supposed to be the work of the aborigines. We had no opportunity to examine it, and consider the story doubtful.

The soil along the Mississippi River in these two counties is a sandy loam; in the interior and western portions it contains generally more clay; a large portion is known as "buckshot" land.

A virgin soil was collected from Col. Anstill's plantation in the western part of Crittenden, known as "cane land." It is of the black sand and stiff clay variety. The cultivated soil was taken from Cook's old field, twenty years in cultivation. A sample of the genuine "gum land" was collected between Col. Anstill's dwelling and the St. Francis River. The "buckshot soil" was taken from Samuel Hinton's place.

These are the principal varieties of soil found in the western part of Crittenden and Mississippi counties. For their analysis see Dr. Peter's Report, Nos. 420, 421, 422, 423.

Craighead is a new county, formed out of a portion of the three counties, Green, Poinsett, and Mississippi. Crowley's ridge passes through it; but level bottom land predominates. In speaking of the "sunk land" district, in its eastern portion, allusion to the parts of this county most suitable for cultivation and most highly productive has already been made.

Soils for analysis were collected from T. Heralson's plantation at the Bay settlement; and also from the Maunelle prairie, near the Deep Landing, on Mr. Foulke's plantation. This prairie contains about a section of land, and is only partially inundated at a time of extreme high water. For the analysis of this prairie soil, see Dr. Peter's Report, Nos. 417, 418, 419.

Mr. Foulke's well-water, in the prairie, was found to contain:

Chloride of sodium (common salt) strong,
Carbonic acid, in small quantity,
Lime, strong, and probably for the most part in a state of chloride.*

* This closes the notes left by Dr. Owen at his decease.—E. T. C.

SURVEY

OF

THE FOURCHE COVE

IN

PULASKI COUNTY, ARKANSAS.

BY

JOSEPH LESLEY,
TOPOGRAPHICAL ASSISTANT.

New Harmony, Dec. 1, 1860.

Richard Dale Owen, M.D.

Sir: According to instructions received from Dr. D. D. Owen, Chief Geologist of the Arkansas Survey, I left this place, in company with Mr. E. T. Cox, Assistant Geologist, on the 30th of October last, to prosecute a special topographico-geological survey of that portion of Pulaski County known as the Fourche Cove.

We arrived at Little Rock on the 5th of November,—were joined by the camp team, which left this place on the 22d October, on the 8th November, and arrived at the Fourche Cove camp the same evening. The examination was finished upon the 20th of November, and the next day camp was broken up and started home,—Mr. Cox and myself arriving here on the 26th of November.

I submit herewith a report of the detailed topographical and geological survey of the district above named, in compiling which I have been greatly aided by the geological examinations made by Mr. E. T. Cox, Assistant Geologist to the Arkansas Survey.

With great respect, I remain yours, &c.,

JOS. LESLEY,

Topographical Geologist.

REPORT

OF THE

DETAILED TOPOGRAPHICAL AND GEOLOGICAL SURVEY OF THE FOURCHE COVE IN PULASKI COUNTY, ARKANSAS.

THE plan pursued in the survey just finished was simple and comparatively inexpensive, and was intended to exemplify how each important geological locality in the State of Arkansas may be the more exactly examined by taking the topographical with the geological features of the country, insuring accuracy of position and consequently the power of determining the course and extent of its mineral deposits.

The plan pursued in this instance was to determine first the position of known points, such as section corners, bridge crossings, &c.; running compass-lines from and to these points; measuring the distances by pacing; noting all irregularities of surface and geological features, and ascertaining heights with an aneroid barometer,—a second barometer being noted at regular intervals during the day at camp, to obtain the compensation for any rise or fall during that day.

The map which accompanies this report embraces that portion of Pulaski County, Arkansas, known as the Fourche Cove district, lying in Sections 21, 22, 23, 24, 25, 26, 27, 28, 33, 34, 35 and 36 of Township 1 north, Range 12 west; and Sections 2, 3, 4, and Fractional Sections 9, 10 and 11 of Township 1 south, Range 12 west, of the fifth Principal Meridian.

Topographically this district resembles, as its name indicates, a two-pronged fork. A ridge of feldspathic rock, running a little east of north for a mile and a quarter through the entire length of Section 4 into the southeast corner of Section 33, there divides,—the western prong bending a little north-northwest and running for three miles through Sections 33, 28, and 22, while the eastern prong continues in a due northeast course for three miles and a quarter through Sections 34, 26, and 24. Between the prongs lies a semi-oval shallow cove. The whole district is inclosed between the Fourche Bayou on the north, the Little Fourche Bayou on

the southwest and west, and the Arkansas River bottom on the southeast and east. The lower road from Little Rock to Pine Bluff skirts its eastern border; the middle Pine Bluff road passes directly through the Cove, and the upper road to the same place passes round its western border.

The western prong of the ridge is cimeter-shaped, and attains an elevation of 300 feet above low water at Fourche Bayou. Its outside flank or escarpment is steep; its inner side slopes gently down to the Cove creek. The eastern prong is nearly straight, attains an elevation of 270 feet, and, like the other, has a gently sloping inner flank and a steep outer one. The regularity of this last is broken by three spurs of less altitude than the prong ridge itself jutting out at right angles to it in a southeast direction into the bottom lands. At the junction of the two prongs is a low watershed, 170 feet above Fourche Bayou. The eastern ridge, continuing past it, forms the handle of the fork. This handle attains also an altitude of 270 feet, and is quite steep on its east side, but less so on its west side. Its nose, low down near the level of the drainage of the country, is partially encircled by extensive deposits of amygdaloid, in which are excavations said to have been made by the Spaniards in their search after precious metals. South of this nose, across one of the branches of Little Fourche, and, as if in continuation of it, rises an outlying spur composed of the same materials as the main ridge, and extends for nearly a mile through Section 9, before passing under the overlying gravel of the tertiary formation. On its western side are several old "Spanish diggings" in the same material as that which encircles the nose of the main ridge.

As I before remarked, there are three spurs shooting out from the side of the eastern prong. The northern, low and broad, passes in a south of east course through Section 25. The middle one divides; one part passing southeast into Section 36, and the other part south into Section 35; together forming a low, broad, undulating ridge, with numerous watersheds. The southern spur passing through the southeast corner of Section 34 into the northwest corner of Section 2, is narrow and straight, and much higher than either of the others. These spurs are each about one mile and a quarter in length, and disappear under tertiary sandstones and gravel.

In the general report already made of this section of the country by the chief geologist, mention is made of the local occurrence of iron ores, feldspathic granites, sandstones, basalt, &c. This survey has accurately located these, and thus enables one to follow their exposures in detail.

Rising then out from the tertiary deposits which surround it on every side this forked ridge offers for the most part a feldspathic rock, varying much in quality,—disintegrating rapidly in some localities,—whilst in others, as in the northeast corner of Section 28, it is hard and compact, and is being now quarried, affording an excellent building material.

North of the point where the two prongs of the ridge issue from the handle a belt of basaltic rock fragments may be traced from the crest of the west prong past the head of the cove, across the east prong and down to the middle spur on the eastern side. This belt is two miles in length, by one-half mile in breadth, covering the east half of the northeast corner of Section 33, the whole of the north half of Section 34, the northwest corner of Section 35, and the west half of the northeast corner of Section 35.

The cove, as before mentioned, is oval-shaped, and is drained by Cove creek and its tributaries, which, after quitting the slopes of the ridges, flow through deposits of tertiary gravel and gravelly iron ore. At a higher level and skirting the broad, flat spurs of the ridges, are to be seen patches of the millstone grit formation, remains of which are also to be found lying upon the east side of the east prong in Sections 25 and 24, and, like those in the cove, seem to lie over the feldspathic rock of the ridge and under the tertiary gravel. In this immediate vicinity (southeast corner of Section 24) is also found an amygdaloid rock similar in appearance to that of the "Spanish diggings."

Descending the eastern slope of the main ridge, the eye wanders over a vast outstretch of pine forest, which extends in a southeast direction towards Pine Bluff. Its northwestern edge is about one and a half miles distant from the crest of the ridge, marking the near edge of the tertiary deposits, which are to be found however in spots in the beds of the small streams up to the very base of the cove ridges. The country covered by these tertiary deposits of gravel, sandstone, and iron ore, is for the most part quite flat, and, in the region examined, has been partially cultivated. Two miles southeast of the cove arise however three hills, two of which attain an elevation of 160 feet, and the third 120 feet above Fourche Bayou. The two northern knobs are joined by a high watershed, and stand upon the line between Sections 2 and 11. The southern hill is much the larger, and occupies with its spurs the whole southern half of Section 11. These hills deserve the careful attention of iron manufacturers, as they have the appearance of being an ore sufficiently rich to use in the high blast furnace. Charcoal for fuel can be obtained from the neighboring forest, and six miles to the north and northwest are beds of limestone.

The general surface of this Fourche Cove district is rough and uninviting, and presents but few inducements to the agriculturist, except, perhaps, in the long and wide bottom of the main and Little Fourche Bayous, where stock-raising could be carried on with profit. The cove itself is uninhabited. On the eastern side of the main Fourche ridge, however, the land is fair, and ten or twelve farms have been opened up, some of them quite recently; the nearness to Little Rock and the high price of pro-

visions there offer sufficient inducements. These farms are mostly small, and lie in the broad tertiary valleys up against the base of the ridge and between its spurs. It is upon two of these farms that the porcelain earth mentioned in the general report is exposed, in wells dug by Mr. George Piles and Mr. Plank. It occurs from twelve to eighteen feet below the general surface of the country, and the thickness of the deposit varies from three to fifteen feet. From surface indications it extends over a considerable area. This porcelain earth or kaolin is white, slightly tinged with gray, and I would call particular attention to it, as an apparently good clay, such as may be used in the manufacture of fine porcelain ware, to be mined at small expense by stripping the light soil which covers it. The neighboring quartzose feldspar rock, though not examined with a view to this subject, may be found to afford a flux to be used in the manufacture of the finer hard porcelains.

The district is poorly timbered, the principal varieties being white and black oak and dogwood, with a thick undergrowth of black jack and scrub oak. The pine timber to the southeast is thick and of large size.

The contour-line relief map of this district, if published, will be found at the end of the volume. The lines represent what would be the shore lines were the waters of the Gulf of Mexico to rise and make this district an island. Each shore line represents 10 feet additional elevation.

CHEMICAL ANALYSIS

OF THE

SOILS,

SUBSOILS, UNDERCLAYS, CLAYS, AND NITRE-EARTHS

OF

ARKANSAS.

COLLECTED BY D. D. OWEN, M.D., PRINCIPAL GEOLOGIST,

AND

ANALYZED BY ROBERT PETER, M.D.,
PROFESSOR OF CHEMISTRY, ETC., ETC., LEXINGTON, KY.

INTRODUCTORY LETTER.

CHEMICAL LABORATORY, LEXINGTON, KENTUCKY,
July 30th, 1860.

DEAR DOCTOR:

According to your instructions, I herewith transmit to you my detailed Report of the Chemical Analyses of Arkansas soils, &c., which have been made in my laboratory during the past and present years. You will find described in it *one hundred and eighty-seven soils, subsoils, and underclays, and two nitre-earths*, collected by you for analysis from thirty-eight counties of Arkansas, during your recent geologico-agricultural examination of that State; and *six soils from Iowa, Minnesota, and Wisconsin*, obtained by you in your former northwestern explorations, and believed by you to be amongst the most fertile of that great region,—the analyses of which are given here for the sake of the comparison of these virgin soils with the soils of Arkansas.

The specimens of soils have generally been collected in sets of three from each locality, viz.: the *virgin or uncultivated soil; the soil of the oldest cultivated field of the neighborhood; and the subsoil of the same.* Sometimes the *underclay*, or the clay beneath the subsoil, has also been collected. The object of this mode of collection being to endeavor to ascertain, by the analyses, not only the chemical composition of these various soils, and any differences which might exist in the soil, subsoil, and underclay, but also to detect any deterioration which may have been caused in the soil of the old fields, by lengthened cultivation in the ordinary way.

In the course of these analyses of the Arkansas soils, the comparative analyses of virgin soil and cultivated soil, were made in fifty-nine different cases; *and in forty-three out of the fifty-nine some diminution, more or less, of the essential ingredients, was observed in the soil of the old field.* In sixteen cases out of the fifty-nine, the soil of the old field showed little or no signs of deterioration, as compared with the virgin soil, or appeared even richer than that; and in several of them a more rich subsoil had doubtless been somewhat mixed with the surface soil by the action of the plough, or had

probably communicated some of its soluble materials to it. Some few cases, however, were decidedly anomalous, in which the old field soil may have been originally richer than the sample taken as virgin soil, or some mistake may have occurred.

This, as you may recollect, coincides to a considerable extent, with the results of a similar examination of soils in the Kentucky Geological Survey, in which this comparison between virgin soil and old field soil of the same locality, was made in *seventy-nine cases, and in seventy-one out of the seventy-nine, the old field soil was found to be less rich in essential ingredients than the virgin soil.** These examinations show the utility of chemical analysis, when conducted carefully and in a *strictly comparative* manner, in pointing out the true cause of the deterioration of the soil, and of the diminution of its productiveness, well known to result from thriftless husbandry: and, consequently, the best modes of restoring it to its original fertility.

The soils of a newly settled country, especially where much of them are of bottom lands subject to occasional overflow, could not be expected to show as marked signs of deterioration by cultivation, as those of an older, longer cultivated, and more elevated region.

This deterioration of the old field soil has now been shown, by comparative chemical analysis (in the Kentucky, Indiana, and Arkansas Surveys), in so great a majority of cases, that the ability of chemical analysis to exhibit the changes of the soil, caused by the culture of crops, may be said to be fully demonstrated, notwithstanding the doubts, in this relation, which have been expressed by some of our best analytical chemists.

These analyses show also a great variety in the soils of Arkansas; which State may boast, amongst her river bottoms and in her *cretaceous* and *Lower Silurian* soils, of as fertile lands as any on the continent. Amongst these cretaceous soils are some (see Nos. 327, 328, 344, 366, 367, and 368, in this Report), which are so rich in *carbonate of lime* that some of them may be classed as *marls* rather than *soils;* and may even be employed as quicklime, if they could be conveniently calcined; and possibly for hydraulic cement; for which purpose some of them deserve a trial. Others, as Nos. 365, 366, and 367, contain so much *oxide of iron* that they resemble in color, as probably in composition, the famous red soil of the island of Cuba, on which the best segar-tobacco is raised; some of these may be employed as a cheap pigment for common painting, being of the nature of red ochre or Spanish brown, which are found to be amongst the best paints which can be used for the preservation of wood, &c., which is exposed to the weather.

It is believed that by no other mode than by chemical analysis, or by the more tedious and laborious method of actual experience, in cropping,

* Similar results were exhibited in the recent Indiana Survey.

for a series of years and published records of the same, can the actual nature, capabilities, and value of the various soils of a State be presented to the public; and that by instituting this Geologico-Agricultural Survey, the State of Arkansas not only aids materially in the progress of the general science of the civilized world, and that of the soil in particular, but takes the most effectual mode of making known to the enlightened immigrant her agricultural riches. In this she has followed the wise lead of the older State of Kentucky, in which, since the institution of her Geological Survey (which is, unfortunately just now, but we hope only temporarily, suspended), the value of the lands in the regions examined and reported on has been very greatly enhanced.

In this, too, the State is performing a duty which she owes to her inhabitants and to the science and agriculture of the world at large; for, from the nature of the case, the analysis of the soils of a State never can be made and published by individual expense and enterprise alone, but must, like all great general surveys and explorations, and works for the common good, be done under the immediate patronage of the Government. In no other way, moreover, can they be done so well or so economically, as when by the influence of that central power a great number of samples, from all parts of the State, are brought together at once, to be *comparatively* examined and studied; more especially as the full experience of the writer has demonstrated, as it is found that no more time and attention, on the part of the analyst is required for the analysis of fifteen or twenty different soils together than would be necessary for a single one taken alone.

With much respect,

I remain, &c.,

ROBERT PETER.

D. D. Owen, M.D.,
State Geologist of Arkansas.

REPORT

OF THE

CHEMICAL ANALYSIS

OF

Soils, Subsoils, Underclays, Clays, and Nitre-Earths,

OR THE

GEOLOGICO-AGRICULTURAL SURVEY

OF THE

STATE OF ARKANSAS.

ARRANGED IN THE ALPHABETICAL ORDER OF THE COUNTIES FROM WHICH THEY WERE OBTAINED.

MADE BY

ROBERT PETER, M.D.,

PROFESSOR OF CHEMISTRY, ETC., ETC., LEXINGTON, KY.

PRELIMINARY REMARKS.

THE term *Essential Materials of the Soil* having been employed in the following pages without explanation, it may be proper to prefix a few explanatory remarks.

NATURE OF SOIL IN GENERAL.

A soil is usually a mixture of a large proportion of sand, of various degrees of fineness (generally very fine, and accidentally mixed with more or less gravel or stones), with smaller quantities of clay (which is principally Alumina), Oxides of Iron and Manganese, Carbonates of Lime and Magnesia, and generally still smaller proportions of *Phosphates*, *Sulphates*, and of the alkalies, *Potash* and *Soda*, and traces of *Chlorine*, *Iodine*, *Fluorine*, &c. This mixture is always colored, more or less, by the remains of the decomposition of animal and vegetable bodies; which, with traces of Ammonia and some strongly adhering mixture, are classed together in the following Report as *Organic and Volatile matters*, and have been denominated by writers "*Humus*, *Geine*, *Vegetable Mould*," &c.

Sometimes, as in the case of some of the *Cretaceous* soils of this State, described in the following Report, much of the sand, &c., is replaced by Carbonate of Lime (chalk or limestone in a pulverulent state); and in the *red soils* the Oxide of Iron abounds greatly. In the heavy clay soils and subsoils and the *clays*, the *Alumina* predominates; in *Peaty* soils the *Organic* matters, and in the *sandy* soils the *Sand* is in superabundance.

ORIGIN OF SOILS.

Some soils have evidently been deposited quietly under water, in former geological ages, in the places in which we find them; the materials not having been subsequently hardened into rock, as has evidently been the case with some of the cretaceous soils of this State. Others have been produced on the spots where they are found by the slow disintegration of

rocks in place under the combined action of the air, water, frost, &c.; which has, no doubt, been the case with many of the soils over the limestone and shaly regions. Some have been produced or essentially modified by deposits from springs of water holding oxide of iron or other materials in solution,—in exemplification of which we may mention some of the *red* soils,—and others have been brought by the transporting power of water, which has carried the fine earthy materials sometimes from distant regions, and deposited them where we find them, as in the soils of the *Drift*, or *Quaternary period.*

By the growth and decay of vegetables and by the nourishment and decomposition of animals on the surface, these mineral materials become more and more mixed with the remains of these organic bodies, and certain of the more soluble of the mineral substances, necessary to vegetable and animal nourishment, are brought more and more to the upper portion of the soil, until a marked difference is to be noticed in the appearance and general qualities of this upper portion as compared with the deeper-seated parts, called the *subsoil.* This upper darker colored portion has received the names *vegetable mould, garden mould,* &c., and is found to be generally quite rich in all the materials essential to vegetable nourishment.

ESSENTIAL MATERIALS OF THE SOIL.

Every portion of the common soil may be said to be *essential* to vegetable nourishment; even the *Silica* (or *Silex*), of which the *Sand* is mainly composed, is required for vegetable growth and animal development, being necessary to their constitution; yet, as sand or silex exists in such very large proportion on the earth's crust that it is always in great superabundance, in even the most sterile soil it is not usual to speak of it as one of the *essential materials* by distinction. As a mechanical agent also sand is indispensable to temper the too great tenacity of the clay with which it is mixed in the soil, and to make it light and permeable to moisture, gases, and the rootlets of plants.

Nor do we generally speak of the *Alumina* (the main constituent of clay) as amongst the *essential materials* of vegetable nourishment, especially as it is doubtful whether it ordinarily enters into the composition of common plants and animals; but yet the presence of this material is necessary to the constitution of a good soil. Alumina (or clay) serves to bind together the too movable sand; and by its superior attraction for moisture, ammonia, and the nutritive gases, and vapors generally, as well as for the alkalies and the products which result from vegetable and animal decomposition, it absorbs, arrests on the surface, and holds these valuable materials for the use of growing vegetables. Too much Alumina renders a soil

too retentive of water, too cold, too stiff and heavy for easy cultivation; whilst too little alumina characterizes that light and sandy soil, which is said to be a *hungry soil*, because it cannot *retain* the fertilizing materials which may be lodged upon it.

Nor is it usual, in common language, to class the *Oxide of Iron* amongst the strictly *essential ingredients* of soils; because, mainly, of its general diffusion and abundance. The glady soil of Camp creek, *Union County*, No. 340, described in the following Report, is a very rare example of a soil which does not contain a sufficient amount of this commonly diffused oxide for vegetable nourishment. Yet the Oxide of Iron is always necessary to organic development; and it is highly probable that without this oxide, and its usually associated oxide of manganese, no vegetable could grow nor animal live healthily; because these oxides are always found amongst the mineral constituents of plants,—and to all animals they are essentially necessary, especially to the composition of the blood and of the red tissues.

Oxide of Iron also, like Alumina, has a considerable attraction for *organic matters*, moisture, and the nutritive gases, especially for Ammonia, which is said never to be absent from it, even in the softer varieties of iron ores; and it is believed, by recent observers, that oxide of iron in the soil, in the presence of moisture, favors the speedy resolution of vegetable and animal remains into products suitable to the nourishment of plants. Its presence is said to be especially favorable to the formation of *nitrates*, which are amongst the best fertilizers.

The *Carbonates of Lime and Magnesia* are usually named amongst the *essential materials* of soils. Both exist in all soils, generally in *limited* and sometimes in *minute* quantities, especially the former. Both *lime* and *magnesia* are essential constituents of the vegetable and animal constitution. The ashes of all plants contain a considerable quantity of them, and especially those of the bark of trees. The ashes of the hemp plant, tobacco, clover, of the wood and bark of the common fruit trees, always contain much lime. The carbonates of lime and magnesia are so soluble in water containing carbonic acid, especially in the presence of the acid organic matters resulting from animal and vegetable decomposition, that atmospheric water passing through the soil which contains these acids, always dissolves out more or less of them. Hence soils, even over limestone strata, and which have probably been formed by the decomposition of lime-rock, usually contains but a limited quantity of carbonate of lime. The water which contains much of the carbonates of lime and magnesia, hold in solution by carbonic acid, is what is called *hard water;* it deposits these earthy salts when the carbonic acid gas is dissipated by boiling or exposure to the air; hence the crust in the boiler; hence stalactites and incrustations in caves. These hard waters generally contain some Phos-

phate and Sulphate of Lime, and more or less Carbonate of Iron, which are also soluble in water containing Carbonic Acid.

Amongst the most important of the essential ingredients of soil, because they are found in them in smaller proportions than the others above-mentioned, are the *Phosphates* and *Sulphates*, and the alkalies, *Potash* and *Soda*.

The *Phosphates*, composed of Phosphoric acid united with lime, magnesia, and sometimes oxide of iron or alumina, exist in all soils, having been derived from the rocks from whence these were formed by disintegration. They are found in all parts of the vegetable structure, but in largest quantity in the seeds or grains, of the ashes of which they form a notable proportion, and to the formation of which, as well as of vegetable tissue in general, they are absolutely necessary. In animals the *Phosphates* form the principal weight of the earthy portion of the bones, and are essential also to the soft tissues and fluids; coming to them, of course, from their food, which in all classes of animals is originally from the vegetable kingdom. A soil which does not contain *Phosphates* in sufficient quantity, although it may be able to nourish, to some extent, the green and woody tissues, will not cause the production of grain or seed, nor much nourishing food for animals.

The Alkalies, *Potash* and *Soda*, which are also positively essential to all kinds of vegetable growth, are, on the other hand, most abundantly required in the herbaceous parts of plants; the green leaves and herbaceous stems and twigs, contain much more of these than the hard woods and their seeds and grains. Hence, whilst the production of crops of the grains tends to exhaust the soil of its Phosphates, that of green or herbaceous crops, as tobacco, clover, the grasses, and the garden vegetables generally, remove from it a larger proportion of its alkalies.

The *Sulphates* (generally Sulphate of Lime, sulphuric acid combined with lime), are also required for the healthy growth of all plants, but more especially for those of the Pea family, as clover, &c.; for the family of the *Cruciferæ*, as the cabbage, turnip, mustard, radish, and for the *Alliaceæ* or *onion* family.

The *organic and volatile matters* of the soil, so called, are of very great importance to vegetable growth, not only furnishing, by their slow decomposition and oxidation, carbonic acid and moisture to plants, but also holding *ammonia*, which contains *Nitrogen* essential to vegetable nourishment, and Phosphates, Sulphates, the Alkalies and Silex, in a soluble condition. They also favor the solution of the nutritive mineral substances from the soil, and exert a great absorbent power for moisture and the gases. By their dark color they also favor the absorption of heat from the rays of the sun.

In the absence of these *organic and volatile matters*, although the soil may be quite rich in the mineral elements of vegetable food, as is the

case with some of the subsoils described in this Report, these are not immediately available for vegetable nourishment, because of the difficulty with which they are brought to a soluble condition favorable for entering into the tissues of plants. The addition of organic manures, or substances containing salts of ammonia, or nitrates, to such a subsoil, tends to make these mineral ingredients soluble and available. The same effect is produced more slowly by exposure of it, on the surface, to air, light, &c., when the successive growths of vegetables, at first, perhaps, scanty, gradually furnish *organic matters* which give it a dark color, and convert it into vegetable mould, and the absorption of atmospheric ammonia, and its subsequent conversion by oxidation into nitric acid, renders the essential mineral materials more and more soluble and available.

These indispensable ingredients of soil, *Lime, Magnesia, Phosphates, Sulphates, Potash,* and *Soda*, exist in it only in very small proportions, and they are taken up to form the substance of all growing vegetables; hence when these are removed from the land in large crops to be consumed in distant places, so that their remains or ashes are not brought back again upon the soil which produced them, the land undergoes a gradual deterioration. This is the cause why an old field is not as productive as the virgin soil; and why, in old countries, where the crops for a long series of years, have been carried off from the fields, they cease to be profitable to the farmer, except by the addition of a large amount of manures, which contain these *essential materials* of the soil.

The usual proportions of these *essential materials* may be seen to advantage by comparing together two of the soils described in the following pages; one of which may be considered amongst the *poorest*, and the other amongst the *richest* which have hitherto been examined from this State, as follows:

SOIL No. 358.—"*Genuine Red or Chocolate-colored Soil, ten to twelve years in cultivation; Garland Crenshaw's Farm, edge of Lost Prairie. Red River Bottom Land, Township 14, Range 26, La Fayette County, Arkansas.*"

SOIL No. 348.—"*Virgin Soil from Section 34, Township 16, Range 17, from Major D. R. Coulter's Farm, near Lisbon, Northwestern part of Union County, Arkansas. On the Waters of Camp Creek. Quaternary formation.*"

Composition, &c., of these Soils		Soil No. 358.	Soil No. 348.
Organic and Volatile Matters,	per cent.	4.781	1.893
Alumina,	"	5.665	.285
Oxide of Iron,	"	6.115	.965
Carbonate of Lime,	"	4 240	.020
Magnesia,	"	2.711	.301
Brown Oxide of Manganese,	"	.140	.140
Phosphoric Acid,	"	.232	.052

Composition, &c., of these Soils.		Soil No. 358.	Soil No. 348.
Sulphuric Acid,	per cent.	.066	.027
Potash,	"	.855	.029
Soda,	"	.159	.095
Sand and insoluble Silicates,	"	74.990	95.890
Moisture, expelled at 400° F.,	"	4.955	0.950
Soluble Matter extracted from 1000 grains by digestion in water charged with Carbonic Acid,	"	8.300	2.224

By the side of these soils presenting great *natural differences of composition*, we will place two, in which this difference has been most probably caused by cultivation in soil which was originally alike in composition, as follows:

SOIL No. 288.—"*Virgin Soil from Dr. T. W. Shore's land, Township* 5, *Range* 14, *&c., Conway County, Arkansas.*"

SOIL No. 289.—"*Same Soil from a field twenty years in cultivation,*" *&c. &c.*

Composition, &c., of these Soils.		Virgin Soil, No. 288.	Old field Soil, No. 289.
Organic and Volatile Matters,	per cent.	3.207	1.895
Alumina,	"	2.625	.490
Oxide of Iron,	"	2.210	1.935
Carbonate of Lime,	"	.121	.024
Magnesia,	"	.371	.371
Brown Oxide of Manganese,	"	.270	.195
Phosphoric Acid,	"	.127	.053
Sulphuric Acid,	"	.050	.028
Potash,	"	.116	.097
Soda,	"	.024	.012
Sand and insoluble Silicates,	"	91.145	93.720
Moisture, expelled at 400° F.,	"	1.800	1.050
Soluble Matters extracted from 1000 grains by digestion in water charged with Carbonic Acid,	"	2.139	1.316

The differences of composition, &c., observable in these soils, may not appear marked to a person not accustomed to this kind of comparison of different soils, but they may be made quite obvious by taking into consideration the immense weight of earth which is contained in an acre of ground, within the depth which is penetrated by the roots of vegetables. This depth is more than one foot in most cases, and sometimes may be stated at several feet. It is probable, that even from a greater depth than that to which vegetable roots attain, capillary attraction, and the diffusion of moisture holding dissolved substances in solution, may bring up nutritive materials to supply the wants of growing crops.

By some weighings, which were made by the writer for the Kentucky Geological Survey, of some dry Blue Limestone soil, the weight of the

earth on one acre of ground, to the depth of one foot only, was found to be more than three millions of pounds avoirdupois. (See Vol. I, Reports of Kentucky Geological Survey, Chemical Report, Fayette County.) Now, if we apply this datum to the above described soils, we find the following results:

The *Phosphoric Acid* of Soil 358, equal to 0.232 per cent, weight	6,960	lbs.	per acre	to 1 foot	depth.
That of Soil 348, " to 0.052 " "	1,560	"	"	"	"
The *difference* in favor of Soil No. 358 is	5,400	"	"	"	"
The *Phosphoric Acid* of Soil No. 288=0.127 per cent, weight	3,810	"	"	"	"
" " " " 289= .053 " "	1,590	"	"	"	"
The *difference* in favor of Soil No. 288 is	2,220	"	"	"	"
The *Potash* of Soil No. 358=0.855 per cent, weight	25,650	"	"	"	"
That of " 348= .029 " "	870	"	"	"	"
The *difference* in favor of Soil No. 358 is	24,780	"	"	"	"
The Potash of Soil No. 288=0.116 per cent, weight	3,480	"	"	"	"
That of " 289= .097 " "	2,910	"	"	"	"
The *difference* in favor of Soil 288 is	570	"	"	"	"

The intrinsic value of Soil No. 358 is therefore much greater than that of No. 348; for, taking only the constituent *Potash* into consideration, the difference in quantity in favor of the former soil in the earth of one acre taken only to the depth of one foot is fifty-four hundred pounds (5400 lbs.) of this valuable material; which, at its commercial value, if it were possible to remove it at once, would more than pay for the land at a high price.

But let us apply these calculations to some of our common crops.

A crop of *Indian Corn*, of fifty bushels to the acre, requires nearly twelve pounds of *Phosphoric Acid* (11.845 lbs.), and a little more than eight pounds (8.060 lbs.) of *Potash* for the grain alone.

A crop of *White Wheat*, of twenty-five bushels to the acre, requires about eleven and a half pounds (11.40 lbs.) of *Phosphoric Acid*, and nearly seven pounds of *Potash* (6.81 lbs.) to perfect the grain.

A crop of Tobacco, of one thousand pounds of leaf and the stalks, requires about eight pounds (8.13 lbs.) of *Phosphoric Acid*, and nearly seventy pounds of *Potash* (69.73 lbs.) It requires about the same weight of *Lime* and various other materials as do also the other crops; but we have selected the *Phosphoric Acid* and *Potash* here for the purpose of the comparison.

These data were obtained by the writer in numerous ash analyses made of Kentucky corn, wheat and tobacco, and reported in the forthcoming Vol. IV of *Reports of the Geological Survey of Kentucky*. On applying them to the four soils described above we find, discarding the fractions, that, whilst

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Soil No. 358 would furnish enough *Phosphoric Acid* for an average crop of Corn for 580 years, and for an average crop of *Wheat* for 605 years, or for an average crop of *Tobacco* for 870 years,

Soil No. 348 could supply this material to the *Corn* crop for 130 years only; the *Wheat* crop for 136 years; or the *Tobacco* crop for 195 years.

Soil No. 288 could supply it to the *Corn crop* for 318 years.
" " " " *Wheat crop* for 330 years.
" " " " *Tobacco crop* for 476 years.

And Soil No. 289 could supply it to the *Corn crop* for only 132 years.
" " " " " *Wheat* crop for 138 years.
" " " " " *Tobacco* crop for 199 years.

And, applying these data to the *Potash*, we find that whilst

Soil No. 358 could supply enough *Potash* for the *Corn* crop for 3206,
" " " " " " *Wheat* crop for 3664 years,
" " " " " " *Tobacco* crop for 366,

Soil 348 could furnish it to the *Corn crop* only for 109 years.
" " " " *Wheat crop* " 124 years.
" " " " *Tobacco crop* " 12 years.

Soil 288 could supply it to the *Corn crop* for 435 years.
" " " " *Wheat crop* for 497 years.
" " " " *Tobacco crop* for 50 years.

And soil 289 could only supply it to the *Corn crop* for 364 years.
" " " " " *Wheat crop* for 415 years.
" " " " " *Tobacco crop* for 42 years.

Calculations like the above can of course only be introduced as very rude *approximations;* for every one acquainted with the difficulties and causes of error which surround analyses and calculations of this sort, knows that it is almost impossible that they should be *strictly accurate* to the pound or to the year; but they show sufficiently well how various crops may draw upon the richness of the soil on which they are cultivated, and how careful chemical analyses of these crops and of the soil may demonstrate the relative value and durability of the latter, and indicate the best modes of maintaining or restoring its fertility. *By no other mode, indeed, can it be as accurately ascertained.*

It may be remarked, in passing, that, as *all* the essential materials of the soil are equally indispensable to vegetable growth, the duration of its productiveness is limited by the smallest proportion of any of these contained in it. Thus in soil No. 358 there is *Potash* enough to supply the grain of an average crop for three thousand two hundred and six years (3206 years), but as its *Phosphoric Acid* would only last for five hundred and eighty years (580 years), the land would cease to produce corn at the end of this shorter period, although it might contain abundance of the other essential materials. Nor could it be made productive of corn again until Phosphoric Acid from some source had been supplied to it. These remarks apply equally well to any one of the essential elements; and the value of chemical analysis is frequently shown by its pointing out the single ingredient,

perhaps, which is wanting to the fertility of a soil; and which, when supplied, may give productiveness to what before was almost sterile.

Moreover, soils may contain an abundance of all the materials essential to vegetable nourishment, and yet, from their *insoluble condition*, or from some unfavorable circumstance, such as want of drainage or too great acidity, they may be as sterile as though these important materials were entirely absent. The writer has attempted, in the following described analysis, to ascertain the relative amount of *immediately available* or *soluble* plant nourishment by digesting the soils in water charged with carbonic acid. The unfavorable circumstances which may render the richest soil unproductive can of course only be ascertained by a local examination, and are obvious to any enlightened observer.

CHEMICAL ANALYSIS OF SOILS, ETC.

ARRANGED IN THE ORDER OF COUNTIES.

ARKANSAS COUNTY.

No. 333. Soil, labelled, "*Virgin Bottom Soil; Moton's Plantation, Arkansas River, Arkansas County, Arkansas.*"

The dried soil is of a light, dirty brownish color.

No. 334. Soil, labelled, "*From a field now in cotton: Moton's Plantation, Arkansas River, &c. &c.*"

The dried soil resembles the preceding, but is a slight shade lighter in color.

These two soils, collected from the same plantation; the one being the virgin soil of the locality, and the other from a field which had been submitted to cultivation for four or six (?) years; were analyzed comparatively, as follows:

One thousand grains of each of these soils, after having been thoroughly air-dried, were digested for one month at the ordinary temperature in a corked bottle, in equal quantities of pure distilled water, which had been charged with *carbonic acid gas* under pressure; after filtration the solution was evaporated to dryness, at the temperature of boiling water (about 212° F.), and carefully analyzed. The results are tabulated below.

The object of this process, to which most of the soils analyzed were submitted, is to ascertain the relative quantity and composition of *matters soluble in carbonated water* which each soil would yield. It is believed that in this way we can estimate the comparative amount of *immediately avail-*

able or *soluble plant nourishment* which is contained in the soils. The water which falls from the atmosphere and moistens the soil—without which, it is well known, no vegetable could grow—always contains a notable quantity of *carbonic acid*, which is always present in the air and in the soil, and is one of the great natural solvents by which the earth is made to give up its nutritious materials for the food of plants; and this process, which we have adopted for the estimation of the *soluble materials* of the soil, imitating to some extent the operations of nature in the action of the atmospheric water upon it, gives us valuable information in relation to its present state of fertility.

The *soluble matters* extracted from these two soils by digestion of a thousand grains of each of them in the water charged with carbonic acid, are as follows:

	No. 333. Virgin Soil.	No. 334. Cultivated Soil.
Organic and Volatile matters,	1.000	0.450
Alumina, and Oxides of Iron and Manganese, and Phosphates,	.460	.127
Carbonate of Lime,	3.427	2.060
Magnesia,	.389	.266
Sulphuric Acid,	.022	.022
Potash,	.106	.064
Soda,	.012	.034
Silica,	.397	.413
Loss,	.137	.131
Soluble extract, dried at 212° F.,	5.950	3.567 grs.

These soils were carefully analyzed, according to the method described fully by the author in the third and fourth volumes of the *Reports of the Geological Survey of Kentucky*, which it is not necessary to detail in this place. The results of the analysis are as follows:

Chemical Composition of these two soils, dried at 400° *F.:*

	No. 333. Virgin Soil.	No. 334. Cultivated Soil.
Organic and Volatile matters,	9.342	6.207
Alumina,	9.600	5 965
Oxide of Iron,		4.615
Carbonate of Lime,	1.470	1.165
Magnesia,	.845	1.496
Brown Oxide of Manganese,	.165	.295
Phosphoric Acid,	.250	.196
Sulphuric Acid,	.067	.050
Potash,	.352	.618
Soda,	.083	.158
Sand and Insoluble Silicates,	78.365	79.390
Total,	100.539	100 155
Moisture, expelled at 400° F., per cent.	5.375	5.110

These are quite rich and fertile soils; the soil of the cultivated field containing an unusually large proportion of *Potash*, which it may owe in part to the admixture by the plough of a subsoil rich in this important material. As the subsoil does not seem to have been collected (at least it did not reach the laboratory), this cannot positively be stated.

On examining the table of the analyses of these two soils it will be seen that, apart from this anomaly in relation to the *potash*—and an increase in the cultivated soil of the magnesia and oxide of manganese, due probably to the same cause—the ordinary effects of cultivation are observed in the diminution of the proportions of the *Organic and Volatile matters*, the *Carbonate of Lime*, and of the *Phosphoric and Sulphuric Acids*, in the soil of the old field; whilst the proportion of the *Sand and Insoluble Silicates* in it is increased.

BRADLEY COUNTY.

No. 369. Soil, labelled, "*Virgin Soil, from E. T. Franklin's yard, Section 22, Township 12, Range 10; two and a half miles northwest of Warren, Bradley County, Arkansas. Tertiary formation.*"

The dried soil is of a dirty yellowish-gray color. Rounded quartz pebbles of various sizes were sifted out of it by the coarse sieve, of one hundred and fifty apertures to the inch.

No. 370. Soil, labelled, "*Same Soil, from an old field, in culture since 1825. E. T. Franklin's farm, &c. (as above), Bradley County.*"

The dried soil is of a dirty yellowish-gray color, a little lighter than the preceding.

No. 371. Soil, labelled, "*Subsoil, from E. T. Franklin's farm, &c. &c. Ten inches below the surface, Bradley County.*"

The dried soil is of a brickdust color.

Digestion of a thousand grains of each of these soils in water charged with carbonic acid, as above described, gave the following results:

Extracted from 1000 Grains of each of the Soils by digestion in Carbonated Water.

	No. 369. Virgin Soil.	No. 370. Old field Soil.	No. 371. Subsoil.
Organic and Volatile matters,	0.667	0.367	0.167
Alumina, and Oxides of Iron and Manganese, and Phosphates,	.389	.150	.060
Carbonate of Lime,	1.927	1.043	.093
Magnesia,	.277	.077	.044
Sulphuric Acid,	.039	.032	.016
Potash,	.145	.089	.071
Soda,	.032	.042	.029
Silica,	.093	.127	.160
Extract, dried at 212° F., grains,	3.569	1.927	0.640

The proportion of *easily soluble* material, available for immediate vegetable nourishment, appears much reduced in the soil of the old field; whilst, as is usually the case, the subsoil, although richer in some of the essential elements, than even the virgin soil, as may be seen in the following table of their chemical composition, yet yields them up with more difficulty to the solvent action of the carbonated water. It has often been observed in practical agriculture that a subsoil, although rich in the essential mineral elements, will not produce well, until by free exposure to the atmospheric agencies, and the admixture with it of organic matters derived from the decay of vegetable and animal substances, its nutritive materials are brought to a soluble state.

The *Chemical Composition of these three soils, dried at* 400° *F.*, is as follows:

	No. 369. Virgin Soil.	No. 370. Old field Soil.	No. 371 Subsoil
Organic and Volatile matters,	3.207	1.643	2.849
Alumina,	2.490	2.290	6.265
Oxide of Iron,	2.740	1.790	3.640
Carbonate of Lime,	.390	.190	.115
Magnesia,	.405	.314	.447
Brown Oxide of Manganese,	.165	.140	.140
Phosphoric Acid,	.095	.094	.129
Sulphuric Acid,	.041	.036	.024
Potash,	.121	.085	.164
Soda,	.006	.088	.048
Sand and Insoluble Silicates,	90.365	93.840	86.640
Total,	100.025	1005.10	100.461
Percentage of *moisture*, expelled at 400° F.,	2.085	1.125	3.500

The proportions of most of the essential ingredients of the soil will be observed to be diminished in that of the old field as compared with the virgin soil. Particularly the *Organic matters*, the *Carbonate of Lime*, *Magnesia*, *Sulphuric Acid* and *Potash*, are less in quantity in the former than in the latter, whilst the sand and insoluble silicates are increased.

The proportion of Phosphoric Acid seems to have been maintained in the cultivated soil, notwithstanding the exhausting action of the crops raised on it, most probably by admixture with it of some of the subsoil, which is more rich in this material than the surface soil. The subsoil contains also a larger proportion of Potash and less Sand, &c., so that deep ploughing and turning up of the subsoil promises to be beneficial to the crops. In consequence of the larger proportions of Alumina and Oxide of Iron which the subsoil contains, it holds a greater quantity of *moisture*, and doubtless much of what is set down in the table as *Organic and Volatile matters* is water.

The next set of soils, from the same county, differ remarkably from the above.

No. 375. Soil, labelled, "*Genuine Red Soil, from the northeast quarter Section 4, Township 11, Range 11; from John H. Marks' farm, on the waters of Lost Creek, northwest part of Bradley County, Arkansas, Tertiary formation.*"

The dried soil is of a reddish chocolate-brown color.

No. 376. Soil, labelled, "*Same soil, from a field twenty-five years in cultivation, northeast quarter Section 4, Township 11, Range 11, John H. Marks' farm, &c. &c.*"

The dried soil is of a brownish-red (Spanish brown) color. Fragments of hard iron ore were sifted out of it with the coarse sieve.

No. 377. Soil, labelled, "*Subsoil of the same old field, John H. Marks' farm, &c. &c.*"

The dried soil is of a deeper and purer red than the preceding.

One thousand grains of each of these soils, thoroughly air-dried and digested for a month in water charged with Carbonic Acid in a closed bottle, and at the ordinary temperature, gave up the following materials, &c.

Extracted from 1000 *Grains by Carbonated Water:*

	No. 375. Virgin Soil.	No. 376. Old field Soil.	No. 377. Subsoil.
Organic and Volatile matters,	0.883	0.600	0.267
Alumina, and Oxides of Iron and Manganese, and Phosphates,	.077	.177	.110
Carbonate of Lime,	1.760	1.377	.260
Magnesia,	.370	.227	.390
Sulphuric Acid,	.045	.025	.022
Potash,	.032	.167	.076
Soda,	.032	.019	.025
Silica,	.193	.163	.130
Loss,	.438	.178	——
Extract, dried at 212° F. (grains).	3.830	2.933	1.280

The *Chemical Composition* of these soils, *dried at* 400° *F.*, was found to be as follows:

	No. 375. Virgin Soil.	No. 376. Old field Soil.	No. 377. Subsoil.
Organic and Volatile matters,	6.806	5.547	5.282
Alumina,	5.985	5.066	10.620
Oxide of Iron,	15.959	23.605	24.205
Carbonate of Lime,	.420	.120	.095
Magnesia,	.413	.604	.543
Brown Oxide of Manganese,	.745	.595	.495
Phosphoric Acid,	.331	.413	.297
Sulphuric Acid,	.075	.058	.050
Potash,	.328	.227	.248
Soda,	——	.075	.067
Sand and Insoluble Silicates,	69.690	63.690	58.098
Total,	100.752	100.000	100.000
Moisture, expelled at 400° per cent,	4.500	4.000	4.775

These soils are remarkable for the very large proportions of *Oxide of Iron* which they contain, which gives them their red color; they, and especially the subsoil, might be used, ground in oil, instead of Spanish brown, for common painting. They also contain more than the usual quantity of oxide of manganese. Their *Phosphoric Acid*, *Sulphuric Acid* and *Potash* are above the average in quantity, and they ought consequently to be quite fertile. The subsoil, however, is somewhat deficient in *Lime*, which is in sufficient abundance in the surface soil.

It would be interesting to experiment in this soil with the Havana Tobacco, from pure imported seed, to ascertain whether it would retain its peculiar good qualities without deterioration, when raised for a number of years, without renewal of the seed. It is said that the finest Cuba Tobacco is cultivated on a red soil, rich in Oxide of Iron, like this.

BENTON COUNTY.

No. 285. Soil, labelled, "*Virgin Soil, from A. B. Greenwood's farm, edge of Bentonville, Benton County, Arkansas. Growth, Black Hickory; undergrowth, Sumac and Hazel. (Subcarboniferous formation.)*

The dried soil is of a dove-gray color.

No. 286. Soil, labelled, "*Soil from A. B. Greenwood's land, twenty-three or twenty-four years in cultivation, in corn, wheat and oats. (Will yield from thirty to thirty-five bushels of oats per acre.*") Benton County.

The dried soil is of a brownish-gray color, a little lighter than the preceding.

No. 287. Soil, labelled, "*Subsoil from the same old field, A. B. Greenwood's farm, edge of Bentonville, Benton County, &c.*"

The dried soil is of a brownish-buff color.

Digested in water, charged with Carbonic Acid, as previously described, one thousand grains of each of these soils gave up of soluble matters as detailed in the following table:

Extracted from 1000 *Grains of each of these Soils by Carbonated Water:*

	No. 285. Virgin Soil.	No. 286. Old field Soil.	No. 287. Subsoil.
Organic and Volatile matters,	0.766	0.600	0.400
Alumina and Oxides of Iron, and Manganese, and Phosphates,	.181	.181	.054
Carbonate of Lime,	1 096	.696	.380
Magnesia,	.039	.105	.116
Sulphuric Acid,	.034	.038	.030
Potash,	.164	.096	.067
Soda,	.011	.007	——
Silica,	.214	.231	.131
Loss,	.500	.179	.122
Extract, dried at 212° F. (grains),	3.005	2.133	1.300

The Chemical Composition of these soils, dried at 400° *F.*, is as follows:

	No. 285. Virgin Soil.	No. 286. Old field Soil.	No. 287. Subsoil.
Organic and Volatile matters,	2.818	1.823	1.494
Alumina,	.840	.425	1.190
Oxide of Iron,	2.000	1.810	2.560
Carbonate of Lime,	.096	.096	.046
Magnesia,	.364	.316	.976
Brown Oxide of Manganese,	.145	.120	.170
Phosphoric Acid,	.078	.160	.040
Sulphuric Acid,	.024	.024	.016
Potash,	.125	.130	.193
Soda,	.025	.038	.037
Sand and Insoluble Silicates,	92.320	93.580	92.195
Loss,	1.165	1.478	1.083
Total,	100.000	100.000	100.000
Moisture, expelled at 400° F.,	1.550	1.000	1.225

Although digestion in the carbonated water shows a smaller quantity of *soluble* matters in the soil of the old field than in the virgin soil, the general analyses, the results of which are detailed in the above table, show some anomalies; for whilst the *Organic and Volatile matters*, the *Alumina and Oxides of Iron and Manganese*, and the *Magnesia*, are in larger proportion in the new soil, the *Carbonate of Lime* and *Sulphuric Acid* appear alike in both, and the *Phosphoric Acid* and *Potash* seem to be in greater amount in the cultivated soil than in the virgin soil. This, in relation to the *Potash*, may be attributed to the still greater proportion present in the *subsoil*, which has doubtless been brought up to the surface, more or less, by the plough; but in the case of the *Phosphoric Acid* this larger quantity in the soil of the old field is an anomaly. Subsoil ploughing, with the use of *Lime*, *Bone-dust*, and *Plaster of Paris*, would improve the productiveness of these soils.

CLARKE COUNTY.

No. 341. Soil, labelled, "*Genuine Black Sticky Wax Soil; from the Buckner farm, Section* 19, *Township* 8, *Range* 19, *Clarke County, Arkansas. Over the Cretaceous formation, but probably deposited in Quaternary Lakes. Growth, sweet gum, mulberry, and walnut.*"

The dried soil is of a mouse-color.

No. 342. Soil, labelled, "*Same Soil, from an old field on the Buckner farm, twenty-five to thirty years in cultivation; Clarke County, &c.*"

Dried soil of a mouse-color; slightly darker than the preceding.

No. 343. Soil, labelled, "*Genuine Virgin Cretaceous Soil, from Col. Boseman's farm, Section* 28, *Township* 17, *Range* 20. *Collected adjacent to a marl bluff on Decepier creek, Clarke County, Arkansas. Growth, gum, hickory, pin and Spanish oak, ash, and sea-ash. Black lands overlying the Cretaceous formation, but probably of recent Quaternary origin.*"

Dried soil of a gray brownish-black color. Effervesces strongly with acid.

No. 344. SOIL, labelled, "*Cultivated Soil, from an old field, thirty to forty years in cultivation; Section 28, Township 7, Range 23; on Col. Boseman's farm, &c. &c.*"

The dried soil is of an olive-gray color. It contains fragments of shells and effervesces with acids.

One thousand grains of each of these four soils, were digested for a month in water charged with Carbonic Acid, as before described, and gave up of *soluble matters* as detailed in the following table:

Extracted from 1000 *Grains of each of these Soils by the Carbonated Water.*

	No. 341. Virgin Soil.	No. 342. Old field Soil.	No. 343. Virgin Soil.	No. 344. Old field Soil.
Organic and Volatile matters, . .	0.550	0.567	2.450	1.633
Alumina, and Oxides of Iron, and Manganese and Phosphates, ...	.093	.060	.120	.047
Carbonate of Lime, ...	1.180	1.310	3.711	8.660
Magnesia, ...	.144	.239	.212	.089
Sulphuric Acid, ...	.014	.022	.027	.027
Potash, ...	.042	.038	.050	.041
Soda, ...	.027	.021	.018	.036
Silica, ...	.347	.317	.347	.363
Soluble extract, dried at 212° F. Grains,	2.397	2.574	6.935	10.896

The extraordinary amount of matter extracted by the carbonated water from soil No. 344, is mainly *Carbonate of Lime;* No. 343 also contains more than the usual quantity of this substance, which is quite soluble in water containing carbonic acid; but, although the former soil yields so large an amount of *extract* in this experiment, the *Potash, Soda, Sulphuric Acid,* and *Magnesia,* appear in but moderate proportions.

The Chemical Composition of these soils, dried at 400° *F.*, was found to be as follows:

	No. 341. Virgin Soil.	No. 342. Old field Soil.	No. 343. Virgin Soil.	No. 344. Old field Soil.
Organic and Volatile matters, . .	8.216	7.443	16.352	4.961
Alumina, ...	12.910	9.010	8 935	6.735
Oxide of Iron, ...	6.350	5.600	5.015	4.650
Carbonate of Lime, ...	2.640	2.215	3.375	35.950
Magnesia, ...	1.737	1.356	1.044	1.306
Brown Oxide of Manganese, . . .	.370	.415	.545	.345
Phosphoric Acid, ...	.302	.191	.165	.234
Sulphuric Acid, ...	.075	.084	.144	.170
Potash, ...	.563	.396	.351	.454
Soda, ...	.111	.193	.090	.109
Sand and Insoluble Silicates, . .	68.315	73.040	64.015	44.040
Loss, ...	——	.114	——	1.046
Total, . .	101.589	100.000	100.031	100.000
Moisture, expelled at 400° F., . .	11.650	9.865	11.025	5.575

These soils are all very rich in the essential elements of vegetable food. If well drained and not too adhesive, they ought to be very productive. They, especially the first three, are remarkable for the large amount of *Hygroscopic moisture* which they retain, No. 341 and 343, having each retained more than eleven per cent., after thorough drying at the ordinary temperature of a room constantly warmed by a stove.

The proportion of *Carbonate of Lime* is so large in them that they all effervesce with acids, whilst in No. 344, it is nearly thirty-six per cent. Indeed this may be considered rather a *marl* than a soil, and might with great advantage be applied to soils deficient in lime, or which had been exhausted by long culture; for which purpose it is fitted also by its large proportions of *Phosphoric and Sulphuric Acids*, *Potash*, and *Soda*. No. 343 contains an unusually large amount of *Organic and Volatile matters*, which, indeed, are abundant in all of them, and aids in giving them their great attraction for moisture. Thorough draining and cultivation will gradually reduce their "*stickyness;*" or the use of sand, especially on No. 341, might produce this result more quickly.

CONWAY COUNTY.

No. 288. Soil, labelled, "*Virgin Soil; Dr. T. W. Shore's land, Township 5, Range 14. Derived from the ferruginous shales of the Millstone Grit. Growth, black oak, hickory, some white and black jack oak. Conway County, Arkansas.*"

The dried soil is of a gray-brown color. Some fragments of ferruginous sandstone were sifted out of it with the coarse sieve.

No. 289. Soil, labelled, "*Same Soil, from Dr. T. W. Shore's farm; twenty years in cultivation, now lying waste. Poor land, &c. &c.*"

The dried soil is of a dirty buff color, lighter than the preceding. A few fragments of ferruginous sandstone were sifted out of it with the coarse sieve.

No. 290. Soil, labelled, "*Subsoil of the same old field; Dr. T. W. Shore's land, Conway County, &c. &c.*"

The dried soil is of a brownish-buff color, lighter than the preceding. It contained some fragments of the ferruginous shale, which were sifted out previous to the analysis, as in the preceding soils.

One thousand grains of each of these three soils were digested for a month in water charged with carbonic acid, as previously described. The *soluble matters* extracted from each are stated in the following table:

Extracted by Carbonated Water from 1000 *Grains of each of these Soils.*

	No. 288. Virgin Soil.	No. 289. Old field Soil.	No. 290. Subsoil.
Organic and Volatile matters,	0.833	0.350	0.317
Alumina and Oxides of Iron, and Manganese, and Phosphates,	.114	.114	.097
Carbonate of Lime,	.696	.420	.260
Magnesia,	.116	.191	.220
Sulphuric Acid,	.028	.022	.028
Potash,	0.90	.061	.044
Soda,	0.31	.018	.006
Silica,	.231	.140	.164
Soluble extract, dried at 212° F. (grains),	2.139	1.316	1.136

As usual, the soil of the old field gives up less soluble material proper for the nourishment of vegetable life than the virgin soil. The subsoil, although really richer in the *essential elements* than the earth on the surface, as may be seen by the chemical analyses, does not give up so much to this solvent as even the old field soil; proving that the nutritive material in it is not all in an *immediately available* condition.

The *Chemical Composition of these soils, dried at* 400° *F.*, was found by analysis to be as follows:

	No. 288. Virgin Soil.	No. 289. Old field Soil.	No. 290. Subsoil.
Organic and Volatile matters,	3.207	1.895	1.469
Alumina,	2.625	.490	3.115
Oxide of Iron,	2.210	1.935	2.010
Carbonate of Lime,	.121	.021	.016
Magnesia,	.371	.371	.236
Brown Oxide of Manganese,	.270	.195	.170
Phosphoric Acid,	.127	.053	.105
Sulphuric Acid,	.050	.028	.016
Potash,	.116	.097	.140
Soda,	.024	.012	.042
Sand and Insoluble Silicates,	91.145	93.720	92.695
Loss,	——	1.183	——
Total,	100.266	100.000	100.044
Moisture, expelled at 400° F., per cent,	1.800	1.050	1.200

The soil of the old field is much poorer than the virgin soil, as exhibited in its smaller proportions of *Organic and Volatile matters*, *Carbonate of Lime*, *Oxide of Manganese*, *Phosphoric and Sulphuric Acids*, *Potash and Soda*, its less *Hygroscopic power*, and its greater proportion of *Sand and Insoluble Silicates.* Its smaller quantities of *Alumina* and *Oxide of Iron* also show the same thing, and may have been caused by the washing out of it of the finer and light particles of the soil during its twenty years' cultivation; for the land which is submitted to cultivation in ploughed or hoed crops, during

which much of the surface is kept bare of vegetation, not only loses some of its essential materials in supplying to the growing crops those mineral elements which are necessary to their formation, but is more injured by the wash of water through it than ground which is covered with a matting of growing plants of any sort. The water of the falling rains, &c., &c., not only dissolves out appreciable portions of its *soluble materials*, which are the most valuable of the ingredients of the soil, but when pouring through it rapidly carries off also in a suspended state some of the finer particles of the insoluble portion; particles which contain the largest amount of Alumina and Oxide of Iron, &c., leaving the coarser particles and the sand in larger quantity behind.

The original soil of this locality cannot be considered very strong, but it is by no means *poor* in its virgin state, and by the judicious use of manures may be made to yield good crops as long as good cultivation of this sort is applied to it. The effects of the ordinary *skinning process* of farming are exhibited in the soil of the *old field*, which would require very heavy manuring and the application of *lime* to bring it up to its original condition. The subsoil is a *little richer* in *Potash* than the virgin soil, but exhibits a deficiency of *Carbonate of Lime*, as well as of *Sulphuric Acid*. Plaster of Paris, slacked lime, in the form of burnt shells, or any common limestone or marl of the neighborhood, with bone-dust, or super-phosphate of lime, or guano, might be advantageously applied to this land. The farmer of this region should study the economy of manures,

CRAWFORD COUNTY.

No. 273. "*Virgin soil, from Arkansas bottom waste land, near Van Buren, Crawford County, Arkansas. Alluvium at the base of the millstone grit.*"*

The dried soil is of a mouse-color.

No. 274. "*Same Soil, from an old field, thirty years in cultivation. Bottom waste land, near Van Buren, &c.*"

The dried soil is of an umber color.

No. 275. "*Subsoil, from the same old field.. Bottom waste land, &c. &c.*"

The dried soil is of a light chocolate color; darker than the next preceding.

Digested for a month in water charged with carbonic acid gas, these soils gave the following results:

* "But derived, no doubt, in part from the red sediment from the ferruginous shales of the saliferous region of the Cherokee country, beyond the State of Arkansas."

Extracted from 1000 *Grains of each of these Soils by the Carbonated Water.*

	No. 273. Virgin Soil.	No. 274. Old field Soil.	No. 275. Subsoil.
Organic and Volatile matters,	1.450	0.966	1.070
Alumina and Oxides of Iron, and Manganese, and Phosphates,	.297	.270	.200
Carbonate of Lime,	2.047	1.887	1.830
Magnesia,	.233	.283	.239
Sulphuric Acid,	.050	.037	.016
Potash,	.103	.170	.152
Soda,	.250	.086	.226
Silica,	.231	.200	.200
Loss,	.239	.074	.360
Soluble extract, dried at 212° F. (grains),	4.900	3.973	4.293

These soils contain a *large proportion of soluble material.* The subsoil also exhibits the same peculiarity.

The *Chemical Composition of these soils, dried at* 400° *F.*, is as follows:

	No. 273. Virgin Soil.	No. 274. Old field Soil.	No. 275. Subsoil.
Organic and Volatile matters,	7.836	6.404	6.582
Alumina,	2.515	4.240	11.363*
Oxide of Iron,	2.360	3.785	
Carbonate of Lime,	.821	.921	.945
Magnesia,	1.170	.731	.436
Brown Oxide of Manganese,	.145	.120	——
Phosphoric Acid,	.164	.264	.213
Sulphuric Acid,	.050	.045	.052
Potash,	.435	.357	.579
Soda,	.153	.032	.136
Sand and Insoluble Silicates,	84.720	82.595	80.595
Loss,	——	.506	——
Total,	100.369	100.000	100.901
Moisture, expelled at 400° F., per cent,	3.975	4.000	4.525

These are very rich soils, containing abundance of the essential mineral elements of vegetable nourishments. The soil of the old field is yet fully equal to the virgin soil, with the exception of a small reduction of its proportion of alkalies. The very rich subsoil has no doubt helped to maintain its fertility. If subject to occasional overflow, this also will restore the essential elements which may have been removed by cultivation.

No. 282. "*Virgin Soil, Sandy Loam, Arkansas bottom land, near Van Buren, Crawford County, Arkansas. Millstone grit formation.*"

The dried soil is of a brownish-umber color.

No. 283. "*Same Soil, from an old field, twenty-five years or more in cultivation. Sandy Loam, Arkansas bottom land, near Van Buren, &c.*"

* With Brown Oxide of Manganese.

Dried soil of a dull brickdust color.

No. 284. "*Subsoil from the same old field, &c. &c.*"

Dried soil of a dull light brickdust color.

One thousand grains of each of these soils, digested in water charged with carbonic acid, gave the following results:

Extracted from 1000 *Grains of each of these Soils by the Carbonated Water.*

	No. 282. Virgin Soil.	No. 283. Old field Soil.	No. 284. Subsoil.
Organic and Volatile matters,	1.183	0.833	0.566
Alumina and Oxides of Iron, and Manganese, and Phosphates,	.221	.290	.081
Carbonate of Lime,	1.463	.763	.113
Magnesia,	.350	.163	.177
Sulphuric Acid,	.030	.050	.054
Potash,	.096	.158	.102
Soda,	.206	.387	.110
Silica,	.332	.281	.131
Extract, dried at 212° F. (grains),	3.881	2.925	1.334

The *Chemical Composition of these soils, dried at* 400° *F.*, was found to be as follows:

	No. 282. Virgin Soil.	No. 283. Old field Soil.	No. 284. Subsoil.
Organic and Volatile matters,	4.791	2.460	2.467
Alumina,	1.690	2.795	3.090
Oxide of Iron,	2.135	2.085	2.360
Carbonate of Lime,	.221	.296	.296
Magnesia,	.880	.683	.731
Brown Oxide of Manganese,	.095	.145	.220
Phosphoric Acid,	.063	.143	.167
Sulphuric Acid,	.033	.042	.024
Potash,	.246	.198	.307
Soda,	.059	.160	.059
Sand and Insoluble Silicates,	88.520	91.110	89.895
Loss,	1.267	——	.384
Total,	100.000	100.117	100.000
Moisture, expelled at 400° F., per cent,	2.425	1.650	1.725

These soils are not quite as rich as the three preceding ones, but yet are very valuable fertile lands, if sufficiently drained. The effects of cultivation appear in the reduced amounts of *Organic and Volatile matters, Potash* and Hygroscopic *moisture*, and the increased quantity of *Sand*, &c.; but, from causes not evident to the writer, the soil of the old field does not show the usual degree of deterioration in regard to most of its essential elements.

No. 309. "*Virgin upland soil, from Josiah Foster's farm, one mile from Van Buren, Crawford County, Arkansas. Derived, in part, from the shales of the millstone grit formation.*"

The dried soil is of a light gray-brown color. It contained about one-fourth

its weight of fragments of ferruginous sandstone, somewhat rounded at their angles. These were sifted out before the chemical analysis was made.

No. 310. "*Same soil, from an old field thirty years in cultivation. Josiah Foster's farm, Crawford County, Arkansas.*"

The dried soil is much lighter colored than the preceding. It contains a few small fragments of ferruginous sandstone.

No. 311. "*Subsoil from the same old field, &c. &c.*"

The dried soil is of a dark-gray buff color. It contains a few fragments of ferruginous sandstone.

Digested for a month in water charged with carbonic acid, it gave the following results, viz.:

Extracted from 1000 *Grains of each of these Soils by the Carbonated Water.*

	No. 309. Virgin Soil.	No. 310. Old field Soil.	No. 311. Subsoil.
Organic and Volatile matters,	0.500	0.273	0.283
Alumina, and Oxides of Iron and Manganese, and Phosphates,	.163	.080	.053
Carbonate of Lime,	.521	.381	.281
Magnesia,	.247	.143	.050
Sulphuric Acid,	.045	.034	.034
Potash,	.226	.021	.036
Soda,	.033	.079	——
Silica,	.254	.364	.164
Loss,	.111	.048	——
Extract, dried at 212° F. (grains),	2.100	1.423	0.901

The Chemical Composition of these soils was found to be as follows, dried at 400° *F.*

	No. 309. Virgin Soil.	No. 310. Old field Soil.	No. 311. Subsoil.
Organic and Volatile matters,	3.176	1.897	2.271
Alumina,	1.690	2.690	3.115
Oxide of Iron,	3.490	1.790	3.490
Carbonate of Lime,	.170	.071	.096
Magnesia,	.293	.293	.285
Brown Oxide of Manganese,	.195	.095	.170
Phosphoric Acid,	.176	.095	.128
Sulphuric Acid,	.041	.028	.013
Potash,	.101	.120	.161
Soda,	.039	.005	.006
Sand and Insoluble Silicates,	90.795	93.300	89.770
Loss,	——	——	.495
Total,	100.166	100.384	100.000
Moisture, expelled at 400° F.,	1.625	1.175	2.025

These soils are not as rich in the essential mineral elements of vegetable food as the *bottom soils* from this county, described above. The soil of the old field shows the usual signs of the exhausting influence of cultivation,

in every particular, except in its proportion of *Potash*, which may have been kept up by admixture of the subsoil by the action of the plough.

FULTON COUNTY.

No. 264. "*Virgin soil, Judge Billing's farm, Township* 18, *Range* 17 *west, Section* 31. *Barrens. Growth, a few scrub hickories, oaks, and walnuts. Lower Silurian period, Fulton County, Arkansas.*"

The dried soil is of a dark umber color.

No. 265. "*Soil eighteen years in cultivation. Judge Billing's farm, &c. &c.*"

Dried soil resembles the preceding. Some fragments of chert sifted out.

No. 266. "*Subsoil of the same old field. Judge Billing's farm, &c.*"

The color of the dried soil resembles that of the two preceding. It contains fragments of chert.

Extracted from 1000 *Grains of each of these Soils, by Digestion for a month in Water charged with Carbonic Acid Gas.*

	No. 264. Virgin Soil.	No. 265. Old field Soil.	No. 266. Subsoil.
Organic and Volatile matters,	0.830	Analysis lost.	0.700
Alumina, and Oxides of Iron and Manganese, and Phosphates,	.113	"	.113
Carbonate of Lime,	1.210	"	.796
Magnesia,	.300	"	.299
Sulphuric Acid,	.035	"	.028
Potash,	.103	"	.038
Soda,	.072	"	.021
Silica,	.264	"	.197
Loss,		"	.191
Extract, dried at 212° F. (grains),	2.927		2.383

The Chemical Composition of these soils, dried at 400° *F.*, was found to be as follows:

	No. 264. Virgin Soil.	No. 265. Old field Soil.	No. 266. Subsoil.
Organic and Volatile matters,	7.575	6.952	6.341
Alumina,	5.165	4.075	7.240
Oxide of Iron,	4.110	3.075	5.360
Carbonate of Lime,	.680	.396	.431
Magnesia,	.341	.787	.863
Brown Oxide of Manganese,	.220	.220	.370
Phosphoric Acid,	.164	.129	.165
Sulphuric Acid,	.084	.059	.059
Potash,	.686	.565	.700
Soda,	.061	.110	.101
Silica,	79.420	83.195	77.345
Loss,	1.494	.437	1.025
Total,	100.000	100.000	100.000
Moisture, expelled at 400° F.,	3.875	3.275	4.200

This land is more than ordinarily rich in the essential elements of vegetable food, and ought to be quite productive and durable. The soil of the old field shows the deteriorating effects of ordinary culture, in the diminished proportions of *Organic and Volatile matters, Carbonate of Lime, Phosphoric* and *Sulphuric Acids,* and *Potash,* as well as in the increased quantity of sand and insoluble silicates. The subsoil is rather richer than the virgin surface soil, especially in *Potash* and *Phosphoric Acid.*

No. 267. "*Virgin Soil; farm of John Winn, Second Upland. Growth, white oak and hickory. Fulton County, Arkansas. Lower Silurian period.*"

The dried soil is of a brownish-gray or dark ash color. A few cherty fragments were sifted out of it.

No. 268. "*Soil, from an old field, thirty years in cultivation; farm of John Winn, &c.*"

The dried soil is lighter colored and more yellowish than the preceding. It contained some fragments of chert.

No. 269. "*Subsoil, of the same old field, &c. &c.*"

The dried soil is of a grayish buff color.

Extracted from 1000 *Grains of each of these Soils by Digestion for a Month in Water charged with Carbonic Acid Gas.*

	No. 267. Virgin Soil.	No. 268. Old field Soil.	No. 269. Subsoil.
Organic and Volatile matters,	2.150	0.993	0.315
Alumina, and Oxides of Iron and Manganese, and Phosphates,	.730	.347	.050
Carbonate of Lime,	2.930	1.483	.497
Magnesia,	.177	.269	.165
Sulphuric Acid,	.016	.022	.022
Potash,	.186	.139	.091
Soda,	.056	.068	.039
Silica,	.464	.397	.347
Loss,	.541	.165	.024
Extract, dried at 212° F. (Grains),	7.250	3.883	1.550

The Chemical Composition of these soils, dried at 400° *F.*, was found to be as follows:

	No. 267. Virgin Soil.	No. 268. Old field Soil.	No. 269. Subsoil.
Organic and Volatile matters,	5.793	3.275	1.794
Alumina,	1.815	2.965	3.265
Oxide of Iron,	1.960	2.235	2.800
Carbonate of Lime,	.396	.171	.071
Magnesia,	.383	.353	.371
Brown Oxide of Manganese,	.320	.195	.270
Phosphoric Acid,	.162	.144	.078
Sulphuric Acid,	.050	.050	.050

	No. 267. Virgin Soil.	No. 268. Old field Soil.	No. 269. Subsoil.
Potash,	.232	.117	.265
Soda,	.031	.017	.016
Sand and Insoluble Silicates,	88.070	90.220	91.345
Loss,	.788	.258	——
Total,	100.000	100.000	100.385
Moisture, expelled at 400° F.,	2.475	1.525	1.100

These are good lands, but not quite as rich as the set just described from this county (Nos. 264, 265, and 266). The soil of the old field contains less *Carbonate of Lime, Magnesia, Oxide of Manganese, Phosphoric Acid, Potash,* and *Soda,* and gave up much less soluble matter to the carbonated water, than the virgin soil. The subsoil is not quite as rich as the surface soil, except in *Potash.*

GREENE COUNTY.

No. 217. "*Virgin Soil, foot of Crowley's ridge. Black sand bottom land. Growth, gum, walnut, and poplar. Undergrowth, pawpaw and spice-wood. William Dean's farm. Quaternary deposits. Greene County, Arkansas.*"

The dried soil is of a light umber color; sandy, containing much clear and some reddish rounded grains.

No. 218. "*Soil, from an old field twenty years in cultivation. William Dean's land. Quaternary deposits. Black sand bottom land, &c. &c.*"

Dried soil, light gray umber color, lighter than the preceding. Sandy like that; containing much clear and some reddish grains.

No. 219. "*Subsoil, of the same old field. William Dean's land, &c. &c.*"

Dried soil of a dirty gray buff color. Sandy like the preceding.

Extracted from 1000 *Grains of the air-dried Soils, by Digestion in Water charged with Carbonic Acid.*

	No. 217. Virgin Soil.	No. 218. Old field Soil.	No. 219. Subsoil.
Organic and Volatile matters,	2.490	1.617	0.633
Alumina, and Oxide of Iron and Manganese, and Phosphates,	.547	.497	.145
Carbonate of Lime,	2.363	1.097	.480
Magnesia,	.257	.150	.089
Sulphuric Acid,	.022	.022	.030
Potash,	.209	.132	.087
Soda,	.099	.013	.024
Silica,	.122	.154	.147
Loss,	.514	.601	.165
Extract, dried at 212° F. (Grains),	6.623	4.283	1.850

The Chemical Composition of these soils, dried at 400 *F.*, was found to be as follows:

	No. 217. Virgin Soil.	No. 218. Old field Soil.	No. 219. Subsoil.
Organic and Volatile matters,	6.243	2.091	1.233
Alumina,	.570	.420	.395
Oxide of Iron,	1.185	.740	1.010
Carbonate of Lime,	.421	.246	.096
Magnesia,	.352	.208	.193
Brown Oxide of Manganese,	.120	.173	.020
Phosphoric Acid,	.183	.115	.078
Sulphuric Acid,	not estimated.	not estim'd.	not estm'd.
Potash,	.152	.079	.132
Soda,	.050	.048	.048
Sand and Insoluble Silicates,	90.045	95.600	97.995
Loss,	.079	.310	——
Total,	100.000	100.000	101 200
Moisture, expelled at 400° F.,	2.300	0.775	0.650

The old field soil is poorer than the virgin soil, and the subsoil more so than either.

No. 228. "*Virgin soil; Mr. H. W. Granede's farm. Genuine black sand land. Growth, poplar, gum, oak. Undergrowth, pawpaw and spice-bush. Quaternary deposits. Greene County, Arkansas.*"

The dried soil is of an umber color. Some small rounded pebbles were sifted out of it with the coarse sieve.

No. 229. "*Same soil, from an old field, twenty years in cultivation. H. W. Granede's farm, &c., Greene County, Arkansas.*"

The dried soil is of an umber color, fully as dark as the preceding. Some small rounded pebbles, of various kinds of quartz, were removed by the coarse sieve.

No. 230. "*Red underclay; Dr. Mellon's land, Greene County, Arkansas. Quaternary deposits.*"

The dried clay is of a light brick-red color.

Digested for a month in water charged with carbonic acid, as previously described, these soils gave the following results, viz.:

Extracted from 1000 Grains of each of these Soils, by Water charged with Carbonic Acid Gas.

	No. 228. Virgin Soil.	No. 229. Old field Soil.	No. 230. Red Underclay.
Organic and Volatile matters,	3.233	1.960	0.800
Alumina, and Oxides of Iron and Manganese, and Phosphates,	1.013	.730	.063
Carbonate of Lime,	2.430	4.430	.147
Magnesia,	.283	——	.136
Sulphuric Acid,	.037	.020	.038
Potash,	.149	——	.031
Soda,	.043	.903*	.062
Silica,	.264	.307	.197
Loss,	.214	——	——
Extract, dried at 212° F. (Grains),	7.666	8.350	1.469

* And Magnesia and loss.

From the larger proportion of Carbonate of Lime in the extract from the soil of the old field, this appears to be in greater quantity than that from the virgin soil. The underclay, from a different locality, but from the same geological formation, gives up much less soluble material than either.

The Chemical Composition of these three soils, was found by analysis to be as follows, dried at 400° F.:

	No. 228. Virgin Soil.	No. 229. Old Field Soil.	No. 230. Red Underclay.
Organic and Volatile matters,	4.825	4.405	4.013
Alumina,	1.490	1.165	15.335*
Oxide of Iron,	1.485	.985	
Carbonate of Lime,	.396	.571	.121
Magnesia,	.296	.265	.400
Brown Oxide of Manganese,	.246	.171	——
Phosphoric Acid,	.259	.193	.283
Sulphuric Acid,	.033	.050	.021
Potash,	.183	.116	.398
Soda,	.058	.058	.055
Sand and Insoluble Silicates,	90.695	91.670	79.435
Loss,	.034	.351	——
Total,	100.000	100.000	100.061
Moisture, expelled at 400 F.,	2.065	1.825	4.950

These and the three other "Black Sand Soils," resemble each other considerably in composition. The red subsoil, containing much more *Alumina and Oxide of Iron*, as well as *Potash* and *Phosphoric Acid*, might no doubt be advantageously applied to these somewhat sandy soils, especially after they have been somewhat worn by cropping. A diminution in the proportions of the essential ingredients *Phosphoric Acid and Potash*, may be noted in the soil of the old field.

No. 220. "*Virgin soil, from the hickory and oak land of Crowley Ridge. William Robener's farm, Greene County, Arkansas. Quaternary deposits.*"

The dried soil is of a dirty gray buff color.

No. 221. "*Soil of an old field, from William Robener's farm, &c.*"

The dried soil is lighter colored than the preceding.

No. 222. "*Subsoil of the old field; William Robener's farm, &c.*"

No. 223. "*Soil from oak and pine land. Ridge four miles south of Gainesville, on the road to Powhatan and Jacksonport, Greene County, Arkansas. Quaternary deposits.*"

The dried soil is of a buff-gray color.

* And Oxide of Manganese.

Extracted from 1000 Grains of each of these Soils by Digestion for a Month in Water charged with Carbonic Acid.

	No. 220. Virgin Soil.	No. 221. Old Field Soil.	No. 222. Subsoil.	No. 223. Oak & Pine Land.
Organic and Volatile matters,	2.110	1.633	1.100	2.166
Alumina, and Oxides of Iron and Manganese, and Phosphates,	.563	.630	.380	.540
Carbonate of Lime,	1.513	1.513	.587	1.247
Magnesia,	.203	.143	.122	.223
Sulphuric Acid,	.033	.018	.022	.018
Potash,	.167	.089	.070	.120
Soda,	.024	.050	.070	.097
Silica,	.264	.297	.131	.214
Loss,	.533	.644	.218	——
Extract, dried at 212 F. (Grains),	5.410	5.017	2.650	4.625

The Chemical Composition of these four soils, dried at 400° F., was found to be as follows:

	No. 220. Virgin Soil.	No. 221. Old Field Soil.	No. 222. Subsoil.	No. 223. Oak & Pine Land.
Organic and Volatile matters,	4.000	3.602	2.329	5.464
Alumina,	1.745	1.070	1.170	1.015
Oxide of Iron,	1.660	1.960	1.960	1.610
Carbonate of Lime,	.296	.346	.271	.231
Magnesia,	.325	.404	.412	.205
Brown Oxide of Manganese,	.245	.298	.195	.171
Phosphoric Acid,	.259	.249	.117	.112
Sulphuric Acid,	.028	.041	.041	.050
Potash,	.188	.162	.207	.147
Soda,	.067	.076	.065	.061
Sand and Insoluble Silicates,	90.695	90.980	91.870	90.934
Loss,	.492	.812	1.363	
Total,	100.000	100.000	100.000	100.000
Moisture, expelled at 400° F.,	1.725	1.450	1.275	2.365

The old field soil shows some diminution of the proportions of the essential ingredients, as compared with the virgin soil. Soil 223 is not quite as good as the other three.

No. 225. "*Virgin soil, Crowley's Ridge, from A. Tennison's farm, Section 11, Township 16, Range 4 east. Quaternary deposits. Greene County, Arkansas.*"

The dried soil is of a light umber color.

No. 226. "*Soil from an old field, thirty-five years in cultivation; A. Tennison's farm, Greene County, Arkansas.*"

The dried soil is of a dirty buff color. Some rounded pebbles of milky quartz and fragments of semi-opal were removed from it by the coarse sieve.

No. 227. "*Subsoil of the same old field; A. Tennison's farm, &c.*" The dried soil is of a buff color.

Extracted from 1000 Grains of each of these Soils, by Digestion for a Month in Water charged with Carbonic Acid.

	No. 225. Virgin Soil.	No. 226. Old Field Soil.	No. 227. Subsoil.
Organic and Volatile matters,	2.660	2.177	1.617
Alumina, and Oxides of Iron and Manganese, and Phosphates,	Accidentally lost.	1.630	.497
Carbonate of Lime,		1.147	.830
Magnesia,		.263	.254
Sulphuric Acid,		.022	.018
Potash,		.163	.151
Soda,		.032	.031
Silica,	.114	.297	.214
Loss,	——	.346	——
Extract, dried at 212° F. (Grains),	7.017	6.077	3.612

After the determination of the weight of the *Extract* from No. 225, by digestion in Carbonic Acid water, and ascertaining the amount of *Organic matter*, &c., and *Silica*, the solution was lost by the upsetting of the beaker in which it was contained, and time did not allow the appropriation of another month for a new digestion.

The Chemical Composition of these three soils, dried at 400° F., was found, by analysis, to be as follows:

	No. 225. Virgin Soil.	No. 226. Old field Soil.	No. 227. Subsoil.
Organic and Volatile matters,	5.080	2.551	2.301
Alumina,	2.565	1.725	3.340
Oxide of Iron,	1.650	1.720	2.085
Carbonate of Lime,	.431	.181	.096
Magnesia,	.490	.323	.537
Brown Oxide of Manganese,	.281	.271	.321
Phosphoric Acid,	.111	.143	.341
Sulphuric Acid,	.050	.033	.041
Potash,	.162	.227	.304
Soda,	.049	.080	.100
Sand and Insoluble Silicates,	89.220	91.645	89.595
Loss,		1.101	.939
Total,	100.089	100.000	100.000
Moisture, expelled at 400° F.,	2.365	1.435	1.815

The soil of the old field has doubtless been improved by the admixture of some of the richer subsoil under the operation of the plough. This subsoil is much richer than the virgin surface soil, and consequently deep ploughing would be very beneficial in this locality.

The foregoing analyses of Greene County soils will doubtless give a good general idea of the composition of the quaternary soils of this region.

No. 224. "*Silicious Clay, below the veiny sandstone, Chalk Bluffs, Greene County, Arkansas. Quaternary deposits.*"

Nearly white, with a slight tinge of yellowish-gray. It burns of a light flesh-color. Makes quite a plastic mass with water.

Composition, dried at 212° F.

Silica,	76.980
Alumina, and Oxides of Iron and Manganese,	15.819
Carbonate of Lime,	.284
Magnesia,	.461
Phosphoric Acid,	.420
Potash,	1.062
Soda,	.420
Water, organic matters, and loss,	5.229
	100.675

This silicious clay might be applied with advantage to poor or exhausted sandy soil, because of its considerable proportions of *Potash and Phosphoric Acid* and its *Alumina*, &c. If it is used for pottery purposes, it would hardly be necessary to mix with it any sand or ground quartz, which are generally required with more aluminous clays. Were it not that the presence of the Oxides of Iron and Manganese causes it to acquire a reddish color in burning, this might be used for the manufacture of queensware. If found to be tough enough after calcination, it might still be employed for a cheaper sort of ware, or for *terra cotta.*

HEMPSTEAD COUNTY.

No. 326. "*Virgin Soil, over the Cretaceous Marly Limestone with Exogyra Costata, on William D. Smith's farm, Section 7, Township 11, Range 25, Hempstead County, Arkansas. Usually limited prairies, surrounded with pine, hickory, ash, bois d'arc (Osage orange). Undergrowth, spice-bush, pawpaw, swamp dogwood, and buckeye.*"

Dried soil mouse-colored. Effervesces slightly with acids.

No. 327. "*Same soil, twenty years in cultivation; from N. D. Smith's farm, &c. &c.*"

The dried soil is of a light umber color. It contains soft cretaceous limestone, and effervesces strongly with acids.

No. 328. "*Subsoil from the same old field; mostly disintegrated shell marl, with vegetable matter. N. D. Smith's farm, &c.*"

The dried soil is of an umber gray color; mostly soft marly limestone.

Extracted from 1000 Grains, by Digestion in Water charged with Carbonic Acid.

	No. 326. Virgin Soil.	No. 327. Old field Soil.	No. 328. Subsoil.
Organic and Volatile matters,	0.500	0.500	0.500
Alumina, and Oxides of Iron and Manganese, and Phosphates,	.733	.080	.063
Carbonate of Lime,	2.323	6.560	6.260
Magnesia,	.940	.144	.274
Sulphuric Acid,	.050	.050	.039
Potash,	.058	.043	.045
Soda,	.057	.044	.040
Silica,	.280	.297	.183
Loss,	—	—	.329
Extract, dried at 212° F. (Grains),	4.941	7.718	7.733

The very large amount of Carbonate of Lime in soils No. 327 and No. 328, causes the *weight* of the *extract* from these, by the carbonated water, to be much greater than that from soil No. 326; but as the latter contains the most alkali, &c., it is probable that it is more nourishing to vegetation than the former.

Chemical Composition of these Soils, dried at 400° F.

	No. 326. Virgin Soil.	No. 327. Old field Soil.	No. 328. Subsoil.
Organic and Volatile matters,	5.387	6.032	5.583
Alumina,	8.235	6.110	5.235
Oxide of Iron,	4.285	3.085	2.535
Carbonate of Lime,	2.415	35.400	50.240
Magnesia,	1.142	1.457	1.313
Brown Oxide of Manganese,	.290	.240	.240
Phosphoric Acid,	.194	.132	.087
Sulphuric Acid,	.067	.127	.096
Potash,	.314	.270	.314
Soda,	.015	—	.095
Sand and Insoluble Silicates,	77.740	47.380	35.140
Total,	100.031	100.233	100.878
Moisture, expelled at 400° F.,	4.875	6.325	4.800

The soil of the old field and the subsoil are *marls* rather than soils. They contain so large a proportion of Carbonate of Lime, especially the latter. It would be interesting to note at large the influence of such an excess of lime on vegetable growth of various kinds. No. 326 has the composition of a very fertile soil.

No. 328. "*White sand, from General S. D. Royston's yard, near his office, in Washington, Hempstead County, Arkansas. This is a loose, sandy soil, overlying Tertiary? and near Green-sand of the Cretaceous. (How much lime and sand?*")

A dirty-gray fine sand, composed of clear grains of hyaline quartz, more or less rounded, with some little organic matters, &c., mixed.

Digested for a Month in Water charged with Carbonic Acid Gas, 1000 Grains of the air-dried Sand gave up the following substances, viz.:

Organic and Volatile matters,	0.333
Alumina, and Oxides of Iron and Manganese, and Phosphates,	.093
Carbonate of Lime,	.460
Magnesia,	.100
Sulphuric Acid,	.022
Potash,	.050
Soda,	.010
Silica,	.180
Brownish-gray Extract, dried at 212° F. (Grains),	1.248

The Chemical Composition of this sand was found by analysis to be as follows, dried at 400° *F.:*

Organic and Volatile matters,	1.519
Alumina, and Oxides of Iron and Manganese,	1.060
Carbonate of Lime,	.190
Magnesia,	.149
Phosphoric Acid,	.094
Sulphuric Acid,	.049
Potash,	.048
Soda,	.026
Sand and Insoluble Silicates,	97.265
Total,	100.400
Moisture, expelled at 400° F.,	0.125

Although nearly a pure sand, containing more than ninety-seven per cent. of this material, this very sandy soil contains enough of the elements of vegetable food to support a growth, by no means scanty, of some sorts of plants, under favorable circumstances of moisture, &c., &c. Like all sandy soils, it readily gives up its nutritive ingredients to the solvent action of the carbonated water. It being in this respect the reverse of the heavy clay soils, or subsoils, which hold, with a strong attraction, the organic matters resulting from animal and vegetable substances, and the other compounds of the soil which serve for vegetable nourishment. Hence, sandy soils are said to be *hungry soils*, requiring frequent manuring to make them productive. This sand would seem hardly to have *Alumina*, &c., enough in its composition to prevent it from shifting by the action of the winds, &c., when in a dry condition.

INDEPENDENCE COUNTY.

No. 240. "*Virgin Soil, upland, from Mr. Peter Moser's farm; Lot 25, Township 15, Range 8 west. Growth, post oak, white oak, hickory, dogwood, and persimmon. Independence County, Arkansas.*"

"*Subcarboniferous formation resting on Silurian.*"

The dried soil is of an umber color. It contains some clear grains of sand and fragments of decomposing chert.

No. 241. "*Same soil, Peter Moser's farm, from a field from fifteen to twenty years in cultivation, in corn, wheat, and oats. Independence County, Arkansas.*"

The dried soil is lighter colored and more yellowish than the preceding. Some fragments of chert were sifted out.

No. 242. "*Subsoil from the same old field; Peter Moser's farm, &c.*"

The dried soil is of a brownish-buff color.

Digested in Water charged with Carbonic Acid Gas, 1000 *Grains of each of these Soils gave the following results:*

	No. 240. Virgin Soil.	No. 241. Old Field Soil.	No. 242. Subsoil.
Organic and Volatile matters,	1.250	1.505	0.400
Alumina, and Oxides of Iron and Manganese, and Phosphates,	.287	.220	.081
Carbonate of Lime,	1.813	1.947	.930
Magnesia,	.381	.274	.111
Sulphuric Acid,	.037	.039	.022
Potash,	.106	.095	.066
Soda,	.016	.017	——
Silica,	.300	.114	.197
Loss,	.243	——	.063
Extract, dried at 212° F. (Grains),	4.433	4.211	1.870

The Chemical Composition of these Soils, dried at 400° *F.,* was found, by analysis, to be as follows:

	No. 240. Virgin Soil.	No. 241. Old Field Soil.	No. 242. Subsoil.
Organic and Volatile matters,	6.874	4.294	3.343
Alumina,	5.440	3.755	4.790
Oxide of Iron,	4.270	4.235	4.485
Carbonate of Lime,	.495	.320	.245
Magnesia,	.493	.497	.561
Brown Oxide of Manganese,	.180	.130	.130
Phosphoric Acid,	.239	.210	.193
Sulphuric Acid,	.045	.033	.042
Potash,	.405	.256	.372
Soda,	.111	.116	.105
Sand and Insoluble Silicates,	81.720	86.020	85.080
Loss,	——	.134	.654
Total,	100 272	100.000	100.000
Moisture, expelled at 400 F.,	3.625	2.100	2.650

These soils contain more than the average proportions of *Potash*, *Phosphoric Acid* and *Carbonate of Lime*, and are doubtless quite fertile. The soil of the old field shows, in the diminished quantities of these materials, as well in the increased amount of *sand*, &c., that it has been somewhat deteriorated by the fifteen to twenty years' cultivation. The subsoil is not richer than the virgin surface soil. If properly drained, these are first-rate lands.

No. 244. "*Virgin Soil; farm of S. M. Cobb, Oil Trough Bottom, Independence County, Arkansas. Subcarboniferous Limestone formation.*"

The dried soil is of an umber color.

No. 245. "*Soil from an old field, upwards of forty years in cultivation, chiefly in corn, and now in cotton; S. M. Cobb's farm, Oil Trough Bottom, &c.*"

The dried soil is lighter and more yellowish than the preceding.

No. 246. "*Subsoil, from S. M. Cobb's farm, Oil Trough Bottom, &c.*"

Dried soil of an umber color, slightly darker than the preceding, but not so dark as the virgin soil.

Digested for a Month in Water charged with Carbonic Acid, 1000 *Grains of each of these Soils, air-dried, gave the following results:*

	No. 244. Virgin Soil.	No. 245. Old Field Soil.	No. 246. Subsoil
Organic and Volatile matters,	1.167	0.450	0.790
Alumina, and Oxides of Iron and Manganese, and Phosphates,	.131	.113.	.081
Carbonate of Lime,	1.213	1.260	1.613
Magnesia,	.183	.296	.120
Sulphuric Acid,	.045	.050	.028
Potash,	.253	.070	.050
Soda,	.061	.044	.012
Silica,	.114	.147	.197
Loss,	.283	.120	.069
Extract, dried at 212° F. (Grains),	3.450	2.550	2.990

The Chemical Composition of these Soils, dried at 400° *F.*, was found, by analysis, to be as follows:

	No. 244. Virgin Soil.	No. 245. Old Field Soil.	No. 246. Subsoil.
Organic and Volatile matters,	8.872	5.744	5.516
Alumina,	5.390	4.715	5.290
Oxide of Iron,	3.385	2.985	3.310
Carbonate of Lime,	.921	.571	.646
Magnesia,	.504	.614	.614
Brown Oxide of Manganese,	.220	.283	1.495
Phosphoric Acid,	.232	.294	.229
Sulphuric Acid,	.042	.059	.042
Potash,	.565	.429	.440
Soda,	.202	.141	.159
Sand and Insoluble Silicates,	79.970	84.395	83.730
Total,	100.303	100.236	101.471
Moisture, expelled at 400° F.,	4.475	2.885	3.025

Like the preceding, these soils must be classed amongst the most valuable and fertile, if well drained and favorably located. They contain even somewhat larger proportions of *Organic and Volatile matters, Carbonate of Lime, Magnesia, Phosphoric Acid and Potash*, than those, and rather smaller percentage of *sand*, &c. The Oxide of Manganese in the subsoil is in much more than the usual proportion. The soil of the old field does not show as much deterioration as might have been expected from its forty years' culture.

No. 303. "*Virgin Soil, from woods. R. A. Childress's farm, two miles from Batesville, Township 14 north, Range 8 west, Section 36. Growth, hickory, oaks, &c. (See E. T. Cox's Notes.) Independence County, Arkansas. Subcarboniferous formation.*"

The dried soil is of a gray-brown color. A fragment of decomposing chert was sifted out of it.

No. 304. "*Soil, from R. A. Childress's farm, from an old field, thirty years in cultivation. Same land as the preceding. Independence County, &c.*"

The dried soil is of a yellowish-brown color.

No. 305. "*Subsoil, of the same old field: R. A. Childress's farm, &c.*"

Dried soil of a yellowish-brown color, lighter than the preceding.

One thousand grains of each of these soils, digested for a month in water charged with carbonic acid, gave the following results:

Extracted from 1000 Grains of each of these Soils by Carbonated Water.

	No. 303. Virgin Soil.	No. 304. Old field Soil.	No. 305. Subsoil.
Organic and Volatile matters,	0.240	0.300	0.450
Alumina, and Oxides of Iron and Manganese, and Phosphates,	.081	.096	.096
Carbonate of Lime,	1.200	.773	.280
Magnesia,	.064	.088	.094
Sulphuric Acid,	.059	.073	.039
Potash,	.079	.073	.070
Soda,	.034	.007	.058
Silica,	.182	.131	.217
Loss,	——	——	.166
Extract, dried at 212° F. (Grains),	1.939	1.541	1.500

The Chemical Composition of these soils, dried at 400° *F.*, was found to be as follows:

	No. 303. Virgin Soil.	No. 304. Old field Soil.	No. 305. Subsoil.
Organic and Volatile matters,	4.204	3.284	2.788
Alumina,	3.325	3.540	2.315
Oxide of Iron,	1.983	2.410	2.310
Carbonate of Lime,	.245	.225	.170

	No. 303. Virgin Soil.	No. 304. Old field Soil.	No. 305. Subsoil.
Magnesia,	.292	.272	.280
Brown Oxide of Manganese,	.345	.320	.295
Phosphoric Acid,	.162	.211	.145
Sulphuric Acid,	.045	.033	.012
Potash,	.205	.142	.207
Soda,	——	——	.004
Sand and Insoluble Silicates,	88.920	88.870	90.130
Loss,	.272	.698	1.344
Total,	100.000	100.000	100.000
Moisture, expelled at 400° F.,	3.075	2.575	2.275

These soils, although quite good and fertile, are not as rich in composition as the two sets just previously described, from this county.

No. 324. "*Soil, at Mr. Tunsall's, Parroquet Bluff, Independence County, Arkansas. Black River bottom soil, derived partly from Lower Silurian formation, and partly from the Quaternary of the east side of Black River.*"

The dried soil is of an umber-gray color, with some darker particles intermixed.

No. 325. "*Soil, derived from Manganese Ore, three miles northeast of Batesville, Independence County, Arkansas. Lower Silurian.*"

Dried soil of a dark clove-brown color. A considerable quantity of fragments of black oxide of manganese (Pyrolusite), was sifted out of it with the coarse sieve, before the analysis.

One thousand grains of each of these two soils digested for a month in water charged with carbonic acid gas, gave the following results:

Extracted from 1000 Grains of each of these Soils, by the Carbonated Water.

	No. 324. Tunsall's Soil.	No. 325. Manganese Soil.
Organic and Volatile matters,	0.360	0.617
Alumina, and Oxides of Iron and Manganese, and Phosphates,	.087	.154
Carbonate of Lime,	.164	2.250
Magnesia,	.094	.333
Sulphuric Acid,	.067	.250
Potash,	.061	.101
Soda,	.080	.022
Silica,	.164	.207
Loss,	.140	——
Extract, dried at 212° F. (Grains),	1.217	3.934

The Chemical Composition of these soils, dried at 400° *F.*, was found to be as follows:

	No. 324. Tunsall's Soil.	No. 325. Manganese Soil.
Organic and Volatile matters,	8.353	9.669
Alumina,	3.615	4.440
Oxide of Iron,	6.140	11.915
Carbonate of Lime,	.345	2.121
Magnesia,	.250	1,301
Brown Oxide of Manganese,	1.270	8.245
Phosphoric Acid,	.282	.368
Sulphuric Acid,	.066	.096
Potash,	.145	.893
Soda,	.156	.047
Sand and Insoluble Silicates,	84.080	60.995
Loss,	.298	——
Total,	100.000	100.090
Moisture, expelled at 400 F.,	4.565	6.150

The manganese soil contains much more than the usual proportion of *Potash*, as well as very large quantities of *Oxides of Iron and Manganese*. The carbonates of lime and organic matters are also in quite large proportion. The influence of the Oxide of Manganese in vegetable nutrition, not having yet been fully understood, although it has been found by recent experiments to be essential, it would be interesting to study the action of such a soil as this on crops of various kinds. In the abstract, the large amount of *Potash* which this soil contains, would make it a valuable addition to other soils which were deficient in this material, or which had been exhausted by long culture, especially in green crops.

No. 379. "*Virgin Soil, A. J. Gaine's farm, near hills, White River bottom, one mile above Batesville, Independence County. Growth, elm, hackberry, scaly bark hickory, Spanish oak, walnut (near the river), and box elder. Nearest formation, Subcarboniferous.*"

The dried soil is of an umber color; the lumps somewhat tenacious.

No. 380. "*Same Soil, in an adjacent field, ten to fifteen years in cultivation, mostly in corn. A. G. Gaine's farm, &c. &c.*"

Dried soil a shade lighter than the preceding; lumps, tenacious.

No. 381. "*Subsoil of the same old field. A. G. Gaine's farm, &c. &c.*"

Dried soil, lighter and more yellowish than the preceding; lumps tenacious.

Extracted from 1000 Grains of each of these Soils by the Carbonated Water.

	No. 379. Virgin Soil.	No. 380. Old field Soil.	No. 381. Subsoil.
Organic and Volatile matters,	1.417	0.663	0.283
Alumina, and Oxides of Iron and Manganese, and Phosphates,	1.448	.633	.060
Carbonate of Lime,	4.317	3.183	1.073

	No. 379. Virgin Soil.	No. 380. Old field Soil.	No. 381. Subsoil.
Magnesia,	.350	.250	.244
Sulphuric Acid,	.045	.045	.045
Potash,	.098	.144	.079
Soda,	.033	.055	.109
Silica,	.380	.430	.243
Extract, dried at 212° F. (Grains),	8.083	5.301	2.140

The Chemical Composition of these soils, dried at 400° *F.*, is as follows:

	No. 379. Virgin Soil.	No. 380. Old field Soil.	No. 381. Subsoil.
Organic and Volatile matters,	8.242	7.145	4.421
Alumina,	5.610	5.410	4.460
Oxide of Iron,	3.140	3.815	4.350
Carbonate of Lime,	1.220	1.165	.695
Magnesia,	.539	.550	.521
Brown Oxide of Manganese,	.090	.165	.190
Phosphoric Acid,	.372	.328	.298
Sulphuric Acid,	.110	.106	.058
Potash,	.406	.416	.376
Soda,	.111	.100	.095
Sand and Insoluble Silicates,	80.265	80.840	83.975
Loss,	——	——	.561
Total,	100.105	100.040	100.000
Moisture, expelled at 400° F., per cent,	6.275	5.400	4.450

These may be classed amongst the richest and most fertile soils; containing as they do more than the average proportions of *Organic and Volatile matters, Carbonate of Lime, Magnesia, Phosphoric and Sulphuric Acids, Potash and Soda.* They are also highly *hygroscopic*, as indicated by the moisture expelled at 400° F. from the soils previously thoroughly air-dried. The subsoil is not quite as rich as the surface soil. The soil of the old field does not differ much from the latter.

No. 382. "*Virgin Soil, close to the river bank; A. G. Gaines' farm, one mile above Batesville, Independence County, Arkansas. Nearest formation is Subcarboniferous.*"

Dried soil of a gray-umber color. More sandy and not so dark-colored as the virgin soil of the preceding set, and the lumps less tenacious. Effervesces slightly with acids.

No. 383. "*Same Soil, near the river; from A. G. Gaines' oldest field, forty years or more in cultivation, chiefly in corn, &c., &c.*"

The dried soil resembles the preceding, a slight shade darker in color. The lumps are quite tenacious.

No. 384. "*Subsoil of the same old field; A. G. Gaines' farm, &c.*"

Dried soil lighter and more yellowish than the preceding; lumps very tenacious.

Extracted from 1000 *Grains of each of these Soils, by Digestion for a Month in Water charged with Carbonic Acid Gas.*

	No. 382. Virgin Soil.	No. 383. Old field Soil.	No. 384. Subsoil.
Organic and Volatile matters,	0.717	0.467	0.283
Alumina, and Oxides of Iron and Manganese, and Phosphates,	.427	.210	.077
Carbonate of Lime,	7.877	1.643	.993
Magnesia,	.206	.211	.122
Sulphuric Acid,	.045	.033	.038
Potash,	.084	.109	.071
Soda,	.373	.092	.010
Silica,	.443	.360	.260
Loss,	——	.158	.046
Extract, dried at 212° F. (Grains),	10.172	3.283	1.900

The very large amount of Carbonate of Lime in the extract from soil No. 382, increases its weight without probably adding much to its nutritive power.

The Chemical Composition of these soils, dried at 400° *F.*, was found to be as follows:

	No. 382. Virgin Soil.	No. 383. Old field Soil.	No. 384. Subsoil.
Organic and Volatile matters,	3.483	3.916	1.914
Alumina,	2.310	3.560	2.810
Oxide of Iron,	2.490	2.690	2.115
Carbonate of Lime,	2.570	.610	.345
Magnesia,	.667	.583	.356
Brown Oxide of Manganese,	.180	.290	.115
Phosphoric Acid,	.193	.212	.209
Sulphuric Acid,	.072	.101	.050
Potash,	.327	.263	.207
Soda,	.088	.090	.104
Sand and Insoluble Silicates,	87.215	88.490	91.590
Loss,	.405	——	.185
Total,	100 000	100.805	100.000
Moisture, expelled at 400° F.,	2.400	2.800	2.075

These are good soils, but are not quite as rich as the preceding set. They contain rather more sand and rather less of the *essential elements* of vegetable nutrition than those. The subsoil is no richer than the surface soil; and the old field soil shows no signs of deterioration. Its fertility may have been maintained by the overflow of the river. Of this, however, the writer is not advised.

IZARD COUNTY.

No. 270. "*Virgin Soil; farm of Widow Lafferty, one mile from Calico. Growth, black oak, hickory, and pine. Izard County, Arkansas. Lower Silurian formation.*"

The dried soil is of a gray-brown color. It contains a large proportion of fine clear rounded grains of quartz sand. Some fragments of chert were sifted out of it.

No. 271. "*Same Soil from an old field; Widow Lafferty's farm, &c.*"

Dried soil of a lighter color than the preceding, approaching dark-gray buff. Sandy, like the preceding. Containing chert and ferruginous quartz.

No. 272. "*Subsoil from the same old field; Widow Lafferty's farm, &c.*"

Dried soil of a gray-buff color. Sandy, like the preceding.

Extracted from 1000 *Grains of each of these Soils, by Digestion for a Month in Water charged with Carbonic Acid Gas.*

	No. 270. Virgin Soil.	No. 271. Old field Soil.	No. 272. Subsoil.
Organic and Volatile matters,	0.923	0.550	0.250
Alumina, and Oxides of Iron and Manganese, and Phosphates,	.196	.196	.049
Carbonate of Lime,	.340	.514	.630
Magnesia,	.133	.256	.111
Sulphuric Acid,	.028	.028	.022
Potash,	.157	.112	.074
Soda,	Not estimated.	.047	.045
Silica,	.197	.231	.197
Loss,	.326	——	——
Extract, dried at 212° F. (Grains),	2.300	1.934	1.378

The Chemical Composition of these Soils, dried at 400° *F., was found to be as follows:*

	No. 270. Virgin Soil.	No. 271. Old field Soil.	No. 272. Subsoil
Organic and Volatile matters,	3.673	1.838	1.705
Alumina,	2.065	1.015	2.290
Oxide of Iron,	1.290	.790	1.165
Carbonate of Lime,	.071	.146	.096
Magnesia,	.285	.290	.296
Brown Oxide of Manganese,	.070	.045	.145
Phosphoric Acid,	.104	.062	.095
Sulphuric Acid,	.024	.016	.011
Potash,	.156	.145	.198
Soda,	.055	.043	.019
Sand and Insoluble Silicates,	91.845	95.270	93.880
Loss,	.362	.340	.100
Total,	100.000	100.000	100.000
Moisture, expelled at 400° F.,	1.465	0.725	0.875

The deterioration of the soil of the old field is shown by the diminished amount of *Extract* dissolved out by the carbonated water, as well as by its smaller proportions of *Organic and Volatile matters*, *Magnesia*, *Oxide of Manganese*, *Phosphoric and Sulphuric Acids*, *Potash and Soda*, the smaller quantity of *moisture* expelled at 400°, and the greater amount of *sand*, &c., exhibited by the general analysis detailed in the above table. The application of Plaster of Paris would be beneficial to this land, because of the small proportion of Sulphuric Acid contained in the soil.

JACKSON COUNTY.

No. 231. "*Virgin Black Sand Soil, Cache Bottom; farm of Thomas McElrath. Growth, sweet gum, elm. Undergrowth, slippery elm and dogwood. Jackson County, Arkansas. Quaternary deposit.*"

Dried soil umber-colored.

No. 232. "*Same Soil from an adjoining field, twenty years in cultivation (one year in cotton, mostly in corn; in* 1857 *in oats); farm of Thomas McElrath, &c.*"

The dried soil is umber-colored, slightly darker than the preceding.

No. 233. "*Subsoil from the farm of Thomas McElrath, &c.*"

The dried soil is slightly lighter-colored and more yellowish than the two preceding.

Extracted from 1000 *Grains of each of these Soils, by Digestion for a Month in Water charged with Carbonic Acid.*

	No. 231. Virgin Soil.	No. 232. Old field Soil.	No. 233. Subsoil.
Organic and Volatile matters,	2.683	1.966	1.544
Alumina, and Oxides of Iron and Manganese, and Phosphates,	.897	.930	.360
Carbonate of Lime,	2.947	4.396	.147
Magnesia,	.195	.200	.170
Sulphuric Acid,	.027	.016	.005
Potash,	.363	.114	.088
Soda,	.030	.019	.041
Silica,	.181	.547	.314
Extract, dried at 212° F. (Grains),	7.323	8.188	2.669

The large amount of *Extract* from No. 232, is more than one-half Carbonate of Lime.

The Chemical Composition of these soils, dried at 400° *F., was found to be as follows:*

	No. 231. Virgin Soil.	No. 232. Old field Soil.	No. 233. Subsoil.
Organic and Volatile matters,	4.759	4.905	1.983
Alumina,	2.725	2.175	2.190
Oxide of Iron,	1.865	1.915	2.065
Carbonate of Lime,	.471	.596	.296
Magnesia,	.408	.473	.425
Brown Oxide of Manganese,	.320	.330	.145
Phosphoric Acid,	.294	.408	.192
Sulphuric Acid,	.033	.059	.045
Potash,	.306	.295	.295
Soda,	.035	.032	.058
Sand and Insoluble Silicates,	88.620	88.445	91 630
Loss,	.164	.367	.676
Total,	100.000	100.000	100 000
Moisture, expelled at 400° F.,	2.875	2.650	1.700

These soils are better than those from the same formation which are described under the head of Greene County. The soil of the old field, No. 232, is no poorer than the surface soil, except apparently in its Potash; whilst the subsoil is not as rich as either of them.

No. 234. "*Virgin Soil, M. L. Robinson's land, two miles north of Jacksonport. Silicious Soil. Growth, black and white oak, some hickory and sweet gum. Jackson County, Arkansas. Quaternary deposit.*"

The dried soil is of a light umber color.

No. 235. "*Soil fifty years in cultivation, now in cotton, and has been for the last twenty years. Never been subsoiled. Farm of M. L. Robinson, &c.*"

Dried soil slightly darker and more yellowish than the preceding.

No. 236. "*Subsoil of the same old field, M. L. Robinson's farm, &c. &c.*"

The dried soil is of a light umber color, more yellowish than the two preceding.

Extracted from 1000 *Grains of each of these Soils (air-dried), by Digestion for a Month in Water charged with Carbonic Acid Gas.*

	No. 234. Virgin Soil.	No. 235. Old field Soil.	No. 236. Subsoil.
Organic and Volatile matters,	1.250	1.333	0.317
Alumina, and Oxides of Iron and Manganese, and Phosphates,	.320	.250	.080
Carbonate of Lime,	.964	1.097	.547
Magnesia,	.099	.122	.122
Sulphuric Acid.	.005	.005	.016
Potash,	.050	.094	.064
Soda,	.029	——	.069
Silica,	.231	.264	.274
Loss,	.218	.318	——
Extract, dried at 212° F.,	3.166	3.483	1.489

The Chemical Composition of these soils, dried at 400° *F., is as follows:*

	No. 234. Virgin Soil.	No. 235 Old field Soil.	No. 236. Subsoil.
Organic and Volatile matters,	1.796	1.654	1.185
Alumina,	1.940	1.275	1.805
Oxide of Iron,	1.190	1.225	1.365
Carbonate of Lime,	.196	.246	.221
Magnesia,	.308	.221	.303
Brown Oxide of Manganese,	.220	.095	.130
Phosphoric Acid,	.094	.143	.114
Sulphuric Acid,	.033	.033	.045
Potash,	.140	.135	.130
Soda,	.042	.055	.023
Sand and Insoluble Silicates,	94 045	94.680	94.770
Loss,	——	.238	——
Total,	100 004	100.000	100 091
Moisture, expelled at 400° F.,	1.175	0.850	0.825

These resemble in composition the other quaternary soils which have been examined, with the exception of the three described immediately preceding, which are a little richer than these. The soil of the old field shows some signs of deterioration, but not so great probably as if it had been cultivated in grain crops. The subsoil is no richer than the surface soil.

No. 237. "*Virgin Soil, H. J. Dowel's land, Township* 14, *Range* 2 *west, Section* 32. *Growth, black oak and some white oak, hickory and sweet gum. Jackson County, Arkansas. Quaternary period?*"

The dried soil is of a gray-brown color. It contains a large proportion of fine sand, composed of clear rounded grains.

No. 238. "*Same Soil, eighteen years in cultivation, now in corn. H. J. Dowel's land, &c.*"

Dried soil like preceding; a little lighter in color. Sandy, like preceding.

No. 239. "*Subsoil of the same old field. H. J. Dowel's farm, &c.*"

Subsoil sandy, like the preceding; lighter colored and more yellowish.

Extracted from 1000 *Grains of each of these Soils, by Digestion for a Month in Water charged with Carbonic Acid Gas.*

	No. 237. Virgin Soil.	No. 238. Old field Soil.	No. 239. Subsoil.
Organic and Volatile matters,	0.383	0.416	0.300
Alumina, and Oxides of Iron and Manganese, and Phosphates,	.064	.081	.064
Carbonate of Lime,	.694	.430	.596
Magnesia,	.163	.150	.129
Sulphuric Acid,	.028	.028	.022

	No. 237. Virgin Soil.	No. 238. Old field Soil.	No. 239 Subsoil
Potash,	.073	.077	.048
Soda,	.045	.032	.022
Silica,	.087	.087	.107
Loss,	.096	——	——
Extract, dried at 212° F. (Grains),	1.633	1.301	1.288

The Chemical Composition of these Soils, dried at 400° *F.*, was found, by analysis, to be as follows:

	No. 237. Virgin Soil.	No. 238. Old field Soil.	No. 239 Subsoil.
Organic and Volatile matters,	1.993	2.047	1.260
Alumina,	.890	.615	1.990
Oxide of Iron,	1.365	1.440	1.410
Carbonate of Lime,	.245	.320	.260
Magnesia,	.665	.244	.261
Brown Oxide of Manganese,	.070	.095	.070
Phosphoric Acid,	.110	.112	.126
Sulphuric Acid,	.022	.028	.025
Potash,	.120	.096	.072
Soda,	Not estimated.	.005	.059
Sand and Insoluble Silicates,	93.995	94.345	94.345
Loss,	.525	.653	.092
Total,	100.000	100.000	100.000
Moisture, expelled at 400° F.,	0.925	1.100	0.800

These soils resemble most of those from the Quaternary deposits which have been examined. The subsoil is no richer than the surface soil, and has already, probably, in consequence of the great freedom with which water penetrates through this sandy medium, communicated some of its soluble materials to the crops grown upon it. The soil of the old field, probably for this reason, does not show as much sign of deterioration as might have been expected.

JOHNSON COUNTY.

No. 318. "*Virgin Soil; Arthur Davis's woodland, one and a half miles east of Clarksville, Johnson County, Arkansas. Principal growth, post oak and black oak, black jack, persimmon, sumach, &c.*" (*Sandstone of the Millstone Grit.*)

Dried soil of a dirty gray-buff color. A considerable quantity of iron gravel, and fragments of ferruginous sandstone removed from it by the coarse sieve.

No. 319. "*Soil from Arthur Davis's old field, fifteen years in cultivation, now in corn. Produces oats best; good for wheat, and moderate for corn.*"

Dried soil of a light gray-brown color. Contains some iron gravel.

No. 320. "*Subsoil, of the same old field; Arthur Davis's farm, &c.*"

Dried soil of a brownish-orange color. A little iron gravel sifted out.

Extracted from 1000 *Grains of each of these Soils, by Digestion for a Month in Water charged with Carbonic Acid.*

	No. 318. Virgin Soil.	No. 319. Old field Soil.	No. 320 Subsoil.
Organic and Volatile matters,	0.366	0.290	0.078
Alumina, and Oxides of Iron and Manganese, and Phosphates,	.094	.094	.047
Carbonate of Lime,	.131	.497	.347
Magnesia,	.123	.138	.077
Sulphuric Acid,	.028	.036	.030
Potash,	.034	.051	.025
Soda,	.032	.011	.032
Silica,	.131	.214	.081
Loss,	011	——	.066
Extract, dried at 212° F. (Grains),	0.950	1.331	0.783

The Chemical Composition of these Soils, dried at 400° *F., was found to be as follows:*

	No. 318. Virgin Soil.	No. 319. Old field Soil.	No. 320. Subsoil.
Organic and Volatile matters,	3.316	3.294	4.147
Alumina,	1.910	3.485	5.110
Oxide of Iron,	3.050	2.755	3.330
Carbonate of Lime,	.045	.170	.070
Magnesia,	.259	.271	.382
Brown Oxide of Manganese,	.145	.180	.270
Phosphoric Acid,	.174	.128	.095
Sulphuric Acid,	.033	.033	.033
Potash,	.092	.044	.273
Soda,	.024	.122	.014
Sand and Insoluble Silicates,	90.545	89.445	86.857
Loss,	.407	.073	——
Total,	100.000	100.000	100.581
Moisture, expelled at 400° F., per cent.,	2.000	2.100	2.000

A diminution in the proportions of the *Phosphoric Acid* and *Potash* appears in the soil of the old field, as compared with the virgin soil. The subsoil appears to be much richer in *Potash* than either; but, in other respects, is not much richer than the surface soil. It contains considerably more Alumina than the virgin soil.

No. 394. "*Virgin Soil; Eli Rayon's land, Section 2, Township 7 south, Range 25. Growth, beech, oak, hickory, and post oak. Undergrowth, sumach. Derived from the shales of the Millstone Grit. Johnson County.*"

Dried soil of a brownish-gray color. Some ferruginous concretions were sifted out of it with the coarse sieve.

No. 395. "*Same Soil from an old field thirty years in cultivation; Eli Rayon's land, &c., &c., Section 2, Township 7, Range 27. Johnson County, Arkansas.*"

The dried soil resembles the preceding,—a slight shade lighter-colored. Some sandy ferruginous concretions sifted out.

No. 396. "*Subsoil of the same land; Eli Rayon's farm, &c.*"

Dried soil of a gray-buff color. Contains a few small sandy ferruginous concretions.

Extracted from 1000 *Grains of each of these Soils, by Digestion for a Month in Water charged with Carbonic Acid.*

	No. 394. Virgin Soil.	No. 395. Old field Soil.	No. 396. Subsoil.
Organic and Volatile matters,	0.850	0.633	0.088
Alumina, and Oxides of Iron and Manganese, and Phosphates,	.317	.247	.177
Carbonate of Lime,	1.030	1.570	.563
Magnesia,	.167	.210	.150
Sulphuric Acid,	.039	.036	.027
Potash,	.195	.202	.029
Soda,	.013	.036	.025
Silica,	.247	.313	.313
Loss,	.259	.386	.245
Extract, dried at 212° F. (Grains),	3.117	3.633	1.617

The Chemical Composition of these Soils, dried at 400° *F.*, was found to be as follows:

	No. 394. Virgin Soil.	No. 395. Old field Soil.	No. 396. Subsoil.
Organic and Volatile matters,	3.254	2.892	2.034
Alumina,	1.240	1.840	1.840
Oxide of Iron,	1.715	1.615	3.190
Carbonate of Lime,	.205	.295	.160
Magnesia,	.546	.314	.314
Brown Oxide of Manganese,	.100	.190	.190
Phosphoric Acid,	.208	.159	.143
Sulphuric Acid,	.058	.055	.023
Potash,	.166	.171	.200
Soda,	.065	.034	.058
Sand and Insoluble Silicates,	92.240	92.865	91.415
Loss,	.203	——	.433
Total,	100.000	100.430	100.000
Moisture, expelled at 400° F.,	1.675	1.475	1.675

The difference in the composition of the virgin soil and that from the old field is not marked. The subsoil also differs but little from either, containing a little more *Oxide of Iron* and *Potash* than those.

LA FAYETTE COUNTY.

No. 354. "*Virgin Soil, from genuine black sandy land, on Col. A. D. Foulke's farm, Township* 14, *Range* 26. *On Red River bottom. Overlying Cretaceous (partly derived from Quaternary?) La Fayette County, Arkansas.*"

Dried soil umber-colored. These soils contain much *fine* sand.

No. 355. "*Same Soil (about* 100 *yards distant), from an old field, thirty to forty years in cultivation. Col. A. D. Foulke's farm, on Red River, &c.*"

Dried soil umber-colored, lighter than the preceding.

No. 356. "*Subsoil from the old field. Col. A. D. Foulke's farm, &c.*"

Dried soil umber-colored, lighter than the preceding, and with a reddish tint.

Extracted from 1000 *Grains of each of these Soils, by Digestion for a Month in Water charged with Carbonic Acid.*

	No. 354. Virgin Soil.	No. 355. Old field Soil.	No. 356. Subsoil.
Organic and Volatile matters,	0 607	0.387	0.317
Alumina, and Oxides of Iron and Manganese, and Phosphates,	.310	.220	.160
Carbonate of Lime,	.377	.797	.459
Magnesia,	.067	.083	.100
Sulphuric Acid,	.054	.027	.033
Potash,	.322	.119	.077
Soda,	.075	.050	.050
Silica,	.233	.230	.173
Loss,	.378	——	——
Extract, dried at 212° F.,	2.423	1.913	1.363

The Chemical Composition of these Soils, dried at 400° *F.*, was found to be as follows:

	No. 354. Virgin Soil.	No. 355. Old field Soil.	No. 356. Subsoil.
Organic and Volatile matters,	2.309	2.253	1.822
Alumina,	1.285	1.240	1.640
Oxide of Iron,	1.340	1.190	1.540
Carbonate of Lime,	.215	.215	.115
Magnesia,	.463	.353	.656
Brown Oxide of Manganese,	.115	.065	.065
Phosphoric Acid,	.176	.126	.126
Sulphuric Acid,	.062	.050	.058

	No. 354. Virgin Soil.	No. 355. Old field Soil.	No. 356. Subsoil.
Potash,	.214	.178	.164
Soda,	.053	.053	.062
Sand and Insoluble Silicates,	93.990	94.490	93.990
Total,	100.222	100.213	100.238
Moisture, expelled at 400° F.,	1.475	1.250	1.225

The soil of the old field shows a marked diminution in the proportions of all its essential constituents, except the *Carbonate of Lime.* The subsoil is hardly as rich as the surface soil.

These present the characters of the best of the Quaternary soils of this region, but are not quite equal in strength to the Black Sand land of Cache Bottom, described under the head of Jackson County.

No. 357. "*Genuine red or chocolate-colored, stiff, cane, cotton, Red River bottom land. Edge of Lost Prairie, but in timbered land. At G. Crenshaw's, Township* 14, *Range* 26. *La Fayette County, Arkansas. This is one of the varieties of the celebrated red cotton lands of Red River bottom.*"

Dried soil of a dark cinnamon color. Effervesces with acids.

No. 358. "*Same Soil, from Garland Crenshaw's farm, ten to twelve years in cultivation, now in cotton. Red River bottom, &c. &c.*"

Dried soil cinnamon colored, slightly lighter than preceding. Effervesces strongly with acids.

No. 359. "*Subsoil from the same old field, &c. &c.*"

Lighter colored than the preceding. Effervesces with acids.

Extracted from 1000 *Grains of each of these Soils, by Digestion for a Month in Water charged with Carbonic Acid.*

	No. 357. Virgin Soil.	No. 358. Old field Soil.	No. 359. Subsoil.
Organic and Volatile matters,	0.933	0.450	0.367
Alumina, and Oxides of Iron and Manganese, and Phosphates,	.143	.243	.248
Carbonate of Lime,	5.813	6.547	5.613
Magnesia,	.433	.356	.422
Sulphuric Acid,	.022	.051	.037
Potash,	.151	.112	.044
Soda,	.138	.064	.042
Silica,	.337	.280	.346
Loss,	—	.197	.353
Extract, dried at 212° F. (Grains),	7.970	8.300	7.467

The Chemical Composition of these Soils, dried at 400° *F.*, was found to be as follows:

	No. 357. Virgin Soil.	No. 358. Old field Soil.	No. 359. Subsoil.
Organic and Volatile matters,	6.587	4.781	3.289
Alumina,	5.590	5.665	4.840
Oxide of Iron,	4.990	6.115	4.715
Carbonate of Lime,	4.540	4.240	4.015
Magnesia,	2.839	2.711	2.209
Brown Oxide of Manganese,	.140	.140	.115
Phosphoric Acid,	.182	.232	.162
Sulphuric Acid,	.084	.066	.041
Potash,	.657	.855	.526
Soda,	.191	.159	.155
Sand and Insoluble Silicates,	74.740	74.990	79.415
Loss,	——	.046	.518
Total,	100.540	100.000	100.000
Moisture, expelled at 400° F.,	5.125	4.955	3.475

These are remarkably rich soils, and, if well drained, must be very productive. Few soils excel them in their proportions of *Potash* and *Carbonate of Lime*. They seem to be well adapted to the production of cotton, and would no doubt yield large crops of good tobacco, if found not to be too stiff. The soil of the cultivated field is even richer in *Phosphoric Acid* and *Potash* than the virgin soil. The subsoil is not quite as rich as either, although very rich.

LAWRENCE COUNTY.

No. 247. "*Red Clay, imbedding Carbonate of Zinc. Hoppe Mines, Lawrence County, Arkansas.*"

The dried clay is of a yellowish light brick-red color, containing fragments of porous decomposed chert and calamine.

Composition, dried at 400° F.

Organic matter, Carbonic Acid and Water, expelled at red heat,	10.625
Alumina and Oxide of Iron,	21.024
Oxide of Zinc with a little Oxide of Manganese,	8.636
Carbonate of Lime,	.721
Magnesia,	.499
Phosphoric Acid,	.222
Sulphuric Acid,	.028
Potash,	.811
Soda,	.087
Sand and Insoluble Silicates,	57.380
	100.033

No. 248. "*Virgin Soil, derived from the upper member of the lead-bearing*

rock. (Contains ferruginous chert.) E. W. Houghton's land, Section 15, *Township* 17, *Range* 2 *west. Growth, black jack, post oak, and small hickory. Lower Silurian period. Lawrence County, Arkansas.*"

The dried soil is of a buff-gray color.

No. 249. "*Same Soil from an old field, forty years in cultivation, now lying waste. E. W. Houghton's farm, &c. &c.*"

The dried soil is more yellowish than the preceding.

No. 250. "*Subsoil of the same old field; E. W. Houghton's farm, Lawrence County Arkansas, &c.*"

The dried soil is of a dark buff color.

Extracted from 1000 *Grains of each of these Soils, by Digestion for a Month in Water charged with Carbonic Acid Gas.*

	No. 248. Virgin Soil.	No. 249. Old field Soil.	No. 250. Subsoil.
Organic and Volatile matters,	0.890	0.933	0.340
Alumina, and Oxides of Iron and Manganese, and Phosphates,	.143	.180	.047
Carbonate of Lime,	.730	.660	.446
Magnesia,	.263	.133	.077
Sulphuric Acid,	.050	.048	.033
Potash,	.112	.061	.041
Soda,	.025	.018	.036
Silica,	.087	.064	.197
Loss,	——	——	.033
Extract, dried at 212° F. (Grains),	2.300	2.097	1.250

The cultivated soil gave up less soluble matter to the water charged with Carbonic Acid, containing less of the *essential* ingredients, than that from the virgin soil. The subsoil, although really richer in valuable mineral elements, gives up, as is usually the case, less of them to the carbonated water.

The Chemical Composition of these Soils, dried at 400° *F., was found to be as follows:*

	No. 248. Virgin Soil.	No. 249. Old field Soil.	No. 250. Subsoil.
Organic and Volatile matters,	2.979	2.019	1.979
Alumina,	2.115	2.255	5.890*
Oxide of Iron,	.576	1.440	
Carbonate of Lime,	.181	.181	.196
Magnesia,	.337	.329	.245
Brown Oxide of Manganese,	.120	.345	——
Phosphoric Acid,	.095	.095	.078
Sulphuric Acid,	.028	.028	.033
Potash,	.154	.120	.328

* And Oxide of Manganese.

	No. 248. Virgin Soil.	No. 249. Old field Soil.	No. 250. Subsoil.
Soda,	.064	.071	.115
Sand and Insoluble Silicates,	92.820	93.320	91.270
Loss,	.531	——	——
Total,	100.000	100.203	100.134
Moisture, expelled at 400° F.,	1.325	0.950	1.050

The influence of the forty years' cultivation is exhibited in the diminished proportions of *Organic and Volatile matters*, *Hygroscopic moisture*, and *Potash*, in the soil of the old field, as well as in the soluble matters extracted by Carbonic Acid,—the deterioration is not so great, however, as might have been expected. The subsoil is richer in all the essential ingredients, except *Phosphoric Acid.*

MADISON COUNTY.

No. 306. "*Virgin Soil from the Brush Creek Barrens; Catlett Fitche's farm, northwest part of Madison County, Arkansas. Growth, black jack and hickory. Subcarboniferous formation.*"

The dried soil is of a dark gray-umber color. It contains fragments of decomposing chert.

No. 307. "*Soil from an old field, twenty-six years in cultivation; Catlett Fitche's farm, &c., &c.*"

Dried soil of a gray-umber color, lighter than the preceding. Contains fragments of decomposing chert.

No. 308. "*Subsoil from the same old field; Catlett Fitche's farm, &c. &c.*"

The dried soil is of a gray-buff color. Contains a few fragments of decomposing chert.

Extracted from 1000 *Grains of each of these Soils, by Digestion for a Month in Water charged with Carbonic Acid.*

	No. 306. Virgin Soil.	No. 307. Old field Soil.	No. 308. Subsoil.
Organic and Volatile matters,	0.550	0.450	0.366
Alumina, and Oxides of Iron and Manganese, and Phosphates,	.096	.146	.163
Carbonate of Lime,	.666	.880	.630
Magnesia,	.193	.270	.117
Sulphuric Acid,	.040	.010	.040
Potash,	.088	.102	.080
Soda,	.082	.028	.030
Silica,	.214	.131	.197
Extract, dried at 212° F.,	1.929	2.047	1.623

The *Chemical Composition of these soils, dried at* 400° *F.*, was found to be as follows:

	. 306. in Soil.	No. 307. Old field Soil.	No. 308. Subsoil.
Organic and Volatile matters, .	4.653	1.895	2.114
Alumina, ...	2.715	1.915	2.325
Oxide of Iron, ...	1.885	1.725	2.160
Carbonate of Lime, . . .	.195	.170	.120
Magnesia, ...	.230	.248	.579
Brown Oxide of Manganese, .	.245	.220	.320
Phosphoric Acid, . . .	.195	.174	.193
Sulphuric Acid, . . .	.041	.033	.022
Potash, ...	.137	.140	.130
Soda, ...	——	.015	.015
Sand and Insoluble Silicates, .	9.945	91.470	91.845
Loss, ...	——	1.995	.177
Total, ...	100.241	100.000	100.000
Moisture, expelled at 400° F., ...	2.750	1.925	1.875

The twenty-six years' cultivation seems to have caused some diminution in the essential materials of the soil, especially in the *Organic matters, Carbonate of Lime, Phosphoric and Sulphuric Acids.* The proportion of *Hygroscopic moisture* is also diminished in the old soil, and its *Sand and Insoluble Silicates* increased. The subsoil is not richer than the surface.

MARION COUNTY.

No. 251. "*Red Clay, stratum six to eight inches thick, below the Magnesian Limestone and Sandstone, on slope of hill, half a mile southwest of Mr. Mitchell's, Marion County, Arkansas.*"

The dried clay is of a brick-red color. A considerable amount of fragments of whitish sandstone were sifted out of it before the analysis was made.

Chemical Composition, dried at 400° *F.*

Organic Matter and Water expelled at a red heat, ...	8.600
Alumina, and Oxides of Iron and Manganese, ...	24.635
Carbonate of Lime, ...	.820
Magnesia, ...	.766
Phosphoric Acid, ...	.173
Sulphuric Acid, ...	.038
Potash, ...	.921
Soda, ...	.453
Sand and Insoluble Silicates, ...	63.615
	100.027

It contains too much *Oxides of Iron and Manganese* to make it useful for the *finer* kinds of pottery ware, and its considerable proportions of *Lime, Magnesia, Potash,* and *Soda*, as well as of these oxides, make it too fusible, at a high temperature, for a *fire clay*. It might be employed for common pottery, or as a marl to exhausted land, especially to that which is rather sandy in its nature.

No. 252. "*Virgin Soil, Prairie Land; William Coker's land, on Sugar-Loaf Creek, Marion County, Arkansas. Lower Silurian period.*"

The dried soil is of an umber color. Some fragments of decomposing chert were sifted out of it.

No. 253. "*Same Soil from an old field, thirty years in cultivation in corn, wheat, and oats; William Coker's farm, &c. &c.*"

Dried soil of a light gray-brown color, much lighter than the preceding. Fragments of decomposing chert were sifted out of it.

No. 254. "*Subsoil from the same old field; William Coker's farm, &c. &c.*"

The dried soil is of a gray-brown color, rather lighter than the preceding. Fragments of decomposing chert were sifted out of it.

Extracted from 1000 *Grains of each of these Soils, by Digestion for a Month in Water charged with Carbonic Acid.*

	No. 252. Virgin Soil.	No. 253. Old field Soil.	No. 254. Subsoil.
Organic and Volatile matters,	1.127	0.700	0.633
Alumina, and Oxides of Iron and Manganese, and Phosphates,	.131	.263	.063
Carbonate of Lime,	.650	.763	.763
Magnesia,	.140	.155	.193
Sulphuric Acid,	.039	.035	.022
Potash,	.087	.127	.081
Soda,	.033	.035	.065
Silica,	.181	.147	.164
Loss,	.095	——	.016
Extract, dried at 212° F. (Grains),	2.483	2.225	2.000

The Chemical Composition of these soils, dried at 400° *F.*, was found to be as follows:

	No. 252. Virgin Soil.	No. 253. Old field Soil.	No. 254. Subsoil.
Organic and Volatile matters,	7.729	4.246	3.534
Alumina,	5.215	2.665	3.340
Oxide of Iron and Manganese,*	3.465	2.725	2.865
Carbonate of Lime,	.096	.396	.296
Magnesia,	.473	.316	.317

* And Oxide of Manganese.

	No. 252. Virgin Soil.	No. 253. Old field Soil.	No. 254. Subsoil.
Phosphoric Acid,	.230	.127	.137
Sulphuric Acid,	.067	.038	.038
Potash,	.301	.312	.294
Soda,	.152	.150	.084
Sand and Insoluble Silicates,	82.520	88.570	88.960
Loss,	——	.455	.135
Total,	100.248	100 000	100.000
Moisture, expelled at 400° F.,	4.265	2.025	1.950

The soil of the old field contains more *Carbonate of Lime* than either the virgin soil or the subsoil. There may be observed in it diminution of the *Organic matters, Alumina, and Oxides of Iron and Manganese, Phosphoric Acid, Sulphuric Acid, Potash, Soda, Hygroscopic Moisture, and Soluble Extract.* The subsoil is not richer than the virgin surface soil.

No. 255. "*Virgin Soil; farm of Jeremiah Young, on the waters of Big Creek, Marion County, Arkansas. Growth, bigbud hickory, black jack, and red oak. Lower Silurian period.*"

The dried soil is of a grayish-brown color. A few small fragments of ferruginous chert were sifted out of it.

No. 256. "*Same Soil from a field twenty-three years in cultivation; farm of Jeremiah Young, &c. &c.*"

Dried soil of a light gray-brown color, lighter than the preceding.

No. 257. "*Subsoil from the same old field; farm of Jeremiah Young, &c. &c.*"

The dried soil is of a gray-buff color, with a brownish tinge.

Extracted from 1000 *Grains of each of these Soils, by Digestion for a Month in Water charged with Carbonic Acid.*

	No. 255. Virgin Soil.	No. 256. Old field Soil.	No. 257. Subsoil.
Organic and Volatile matters,	1.333	0.950	0.683
Alumina, and Oxides of Iron and Manganese, and Phosphates,	.164	.124	.113
Carbonate of Lime,	1.740	1.063	.730
Magnesia,	.194	.052	.094
Sulphuric Acid,	.056	.050	.039
Potash,	.252	.183	.051
Soda,	——	.074	.079
Silica,	.181	.240	.081
Loss,	.130	.297	.130
Extract, dried at 212° F. (Grains),	4.050	3.033	2.000

The Chemical Composition of these soils, dried at 400° *F., was found to be as follows:*

	No. 255. Virgin Soil.	No. 256. Old field Soil.	No. 257. Subsoil.
Organic and Volatile matters,	4.308	4.084	2.399
Alumina,	2.615	2.465	3.340
Oxides of Iron and Manganese.	2.165	1.990	2.665
Carbonate of Lime,	.349	.396	.196
Magnesia,	.304	.355	.290
Phosphoric Acid,	.193	.176	.117
Sulphuric Acid,	.028	.033	.025
Potash,	.236	.188	.249
Soda,	.120	.134	.141
Sand and Insoluble Silicates,	89.920	90.460	90.795
Total,	100.235	100 281	100.217
Moisture, expelled at 400° F.,	1.950	1.825	1.300

The soil of the old field shows a diminution in the proportions of most of its essential ingredients, in its amount of *Soluble Extract* and *Hygroscopic Moisture*, as well as a slight increase of the *sand*, &c., as compared with the virgin soil. The subsoil is not richer than the surface soil. These are good soils, but with rather a smaller proportion of *Sulphuric Acid* than usual. It might be found, therefore, that the use of Plaster of Paris would be advantageous to some crops.

No. 261. "*Virgin Soil; John W. Haley's farm. Barrens. Township* 19, *Range* 14, *Section* 23. *Growth, rosin-weed and grass. Lower Silurian period. Marion County, Arkansas.*"

The dried soil is of a dark umber color. Some fragments of chert were sifted out of it.

No. 262. "*Soil from an old field, twenty years in cultivation, now in sweet potatoes; John W. Haley's farm, &c. &c.*"

Dried soil umber-colored, lighter than the preceding.

No. 263. "*Subsoil from the same old field; John W. Haley's farm.*"

The dried soil is lighter and more yellowish than the preceding.

Extracted from 1000 *Grains of each of these Soils, by Digestion for a Month in Water charged with Carbonic Acid.*

	No. 261. Virgin Soil.	No. 262. Old field Soil.	No. 263. Subsoil.
Organic and Volatile matters,	1.383	0.950	0.850
Alumina, and Oxides of Iron and Manganese, and Phosphates,	.547	.547	.331
Carbonate of Lime,	2.530	2.763	1.130
Magnesia,	.505	.260	.291
Sulphuric Acid,	.032	.021	.028
Potash,	.121	.141	.054
Soda,	.101	.075	.050
Silica,	.397	.231	.297
Loss,	.201	.279	——
Extract, dried at 212° F. (Grains),	5.817	4.767	3.031

The *Chemical Composition of these soils, dried at* 400° *F.*, was found to be as follows:

	No. 261. Virgin Soil.	No. 262. Old field Soil.	No. 263. Subsoil.
Organic and Volatile matters,	11.011	8.964	6.133
Alumina,	5.015	4.040	3.790
Oxide of Iron,	3.810	2.910	3.350
Carbonate of Lime,	.646	.696	.346
Magnesia,	.815	.489	.526
Brown Oxide of Manganese,	.295	.195	.295
Phosphoric Acid,	.147	.163	.162
Sulphuric Acid,	.084	.079	Not estimated.
Potash,	.693	.478	.430
Soda,	.583	.143	.117
Sand and Insoluble Silicates,	76.295	80.645	83.220
Loss,	.606	1.198	1.631
Total,	100.000	100.000	100.000
Moisture, expelled at 400° F.,	4.650	3.335	2.825

These soils contain a large amount of *Organic and Volatile matters*, like prairie soils in general, and are very rich in all the essential mineral elements of vegetable food. If properly drained they are very fertile soils. The old field shows by the analysis marked signs of deterioration, except in its *Carbonate of Lime* and *Phosphoric Acid*, but is yet quite a rich soil. The subsoil does not appear to be stronger than the surface soil.

MONROE COUNTY.

No. 297. "*Virgin Soil, Alfred Mullen's farm, Section* 25, *Township* 1 *north, Range* 3 *west. Average land; best adapted to cotton. Growth, sweet gum, dogwood, and elm, some hickory and oak. Monroe County, Arkansas. Derived from Quaternary formation.*"

Dried soil of a light umber color. Contains much fine clear sand.

No. 298. "*Same land; Alfred Mullen's farm, fourteen years or more in cultivation, now in cotton. Monroe County, Arkansas.*"

Dried soil of a light umber color. Does not contain as much clear sand as the preceding.

No. 299. "*Subsoil from the same land, &c. &c.*"

Dried soil lighter than the preceding (light gray-brown color), contains less clear sand than the preceding.

Extracted from 1000 *Grains of each of these Soils, by Digestion for a Month in Water charged with Carbonic Acid.*

	No. 297. Virgin Soil.	No. 298. Old field Soil.	No. 299. Subsoil.
Organic and Volatile matters,	0.300	0.300	0.250
Alumina, and Oxides of Iron and Manganese, and Phosphates,	.113	.133	.080
Carbonate of Lime,	.663	.988	.846
Magnesia,	.188	.107	.108
Sulphuric Acid,	.046	.028	.041
Potash,	.134	.120	.070
Soda,	.012	.005	.006
Silica,	.164	.114	.191
Loss,	——	.138	——
Extract, dried at 400° F.,	1.620	1.933	1.592

The Chemical Composition of these Soils, dried at 400 *F.*, was found to be as follows:

	No. 297. Virgin Soil.	No. 298. Old field Soil.	No. 299. Subsoil.
Organic and Volatile matters,	2.193	3.669	1.959
Alumina,	2.740	1.940	2.065
Oxide of Iron,	1.100	1.660	1.750
Carbonate of Lime,	.145	.320	.195
Magnesia,	.256	.266	.267
Brown Oxide of Manganese,	.170	.145	.120
Phosphoric Acid,	.090	.156	.051
Sulphuric Acid,	.015	.058	.033
Potash,	.143	.101	.132
Soda,	.032	.013	——
Sand and Insoluble Silicates,	93.970	90.830	92.645
Loss,	——	.842	.783
Total,	100.881	100.000	100.000
Moisture, expelled at 400° F.,	1.525	2.315	1.700

The soil of the old field seems to have been naturally stronger than that which was selected as the virgin soil of this locality. It contains less of the fine clear sand which is very evident in the latter, and has more of the *essential* ingredients, with the exception of *Potash*, than either it or the subsoil.

NEWTON COUNTY.

No. 291. "*Virgin Soil; Mr. R. W. Harrison's land, adjoining the town of Jasper, Newton County, Arkansas. Growth, black, white, red, and water oak, black and sweet gum. Subcarboniferous formation, resting on Lower Silurian.*"

The dried soil is of a light umber color. Some ferruginous and cherty fragments were sifted out of it with the coarse sieve.

No. 292. "*Soil from an old field, twenty years in cultivation, most of the time in corn, now in oats. Mr. R. W. Harrison's land, &c. &c.*"

Dried soil a little lighter colored and more yellowish than the preceding. Some cherty and ferruginous fragments sifted out of it.

No. 293. "*Subsoil of the preceding. R. W. Harrison's land, &c. &c.*"

Dried soil of a dirty brownish buff-color. A few cherty fragments sifted out of it.

Extracted from 1000 *Grains of each of these Soils, by Digestion for a Month in Water charged with Carbonic Acid.*

	No. 291. Virgin Soil.	No. 292. Old field Soil.	No. 293. Subsoil.
Organic and Volatile matters,	1.066	0.366	0.333
Alumina, and Oxides of Iron and Manganese, and Phosphates,	.113	.113	.096
Carbonate of Lime,	2.080	.963	.880
Magnesia,	.027	.167	.143
Sulphuric Acid,	.056	.053	.029
Potash,	.166	.126	.066
Soda,	.037	——	.041
Silica,	.147	.131	.147
Loss,	.374	.031	——
Extract, dried at 212° F., (Grains),	4.066	1.950	1.735

The Chemical Composition of these soils, dried at 400° *F.*, was found to be as follows:

	No. 291. Virgin Soil.	No. 292. Old field Soil.	No. 293. Subsoil.
Organic and Volatile matters,	7.722	3.534	2.303
Alumina,	2.090	2.090	3.140
Oxide of Iron,	2.110	2.250	2.460
Carbonate of Lime,	.746	.421	.196
Magnesia,	.313	.396	.317
Brown Oxide of Manganese,	.445	.395	.470
Phosphoric Acid,	.131	.118	.084
Sulphuric Acid,	.050	.033	.042
Potash,	.137	.127	.170
Soda,	.054	.025	.054
Sand and Insoluble Silicates,	84.945	90.420	90.845
Loss,	1.257	.191	——
Total,	100 000	100.000	100.111
Moisture, expelled at 400° F.,	4.500	2.375	2.075

These are very good soils, but do not contain as much *Potash*, *Phosphoric Acid, &c.*, as some of the richest of the Arkansas land. The soil of the old

field contains less *Organic and Volatile matters*, *Carbonate of Lime*, *Oxide of Manganese*, *Phosphoric and Sulphuric Acid*, *Potash and Soda*, and more *sand*, *&c.*, than the virgin soil. It gave less *soluble extract* to the carbonated water, and holds less *hygroscopic moisture*. The subsoil contains a little more *Potash*, but does not seem to be generally richer than the surface soil.

No. 404. "*Average sample of Nitre-Earth, from J. S. Thompson's Nitre Cave, on Cave Creek, Newton County, Arkansas.*"

A cinnamon-colored earth, mixed with shaly fragments of limestone, which are generally friable, and a few ancient fragments of bones, some of which are quite small.

Chemical Analysis. One hundred parts of the air-dried earth gave up to water more than six parts of *soluble matters*, which was very deliquescent even at the boiling heat of water. After several days drying at this temperature it still appeared like thick honey in color and consistence.

The composition of this saline matter, thus dried, was found to be as follows:

Lime, ...	1.445
Magnesia, ...	.119
Alumina, ...	a trace.
Potash, ...	.599
Soda, ...	.136
Sulphuric Acid, ...	.357
Chlorine, ...	.051
Nitric Acid, ...	2.920—equal to 5.47 per cent of the earth of *Nitre*.
Silica, ...	not estimated.
Water and loss, ...	.705
Percentage of saline matters,	6.332

An experiment was made by lixiviating five hundred grammes of the earth with distilled water, and precipitating it with a solution of pure carbonate of potash, which had been dried by ignition. The mixed carbonates of lime and magnesia, thus precipitated, weighed 12.35 grammes, and 26.33 grammes of crystallizing *nitre*, which looked quite white and pure, was obtained. This is equivalent to 2.91 per cent of *nitric acid*, or 5.26 per cent of *nitre* to the air-dried earth. The solution of the nitre deposited some sulphates, &c., during crystallization. The quantity of *dry* carbonate of potash used was 19.24 grammes, which was in slight excess; so that nearly four per cent of the dry carbonate of potash is required to convert the *earthy nitrates* into nitre.

These earthy nitrates, of lime and magnesia, give the deliquescent and oil-like character to the evaporated lixivium of this earth. No substance

of a fatty nature, supposed by the nitre manufacturer to exist in it, was to be discovered; and the presence of this deliquescent material in his crude nitre, interfering with the crystallization, is evidence that he was throwing away some of the earthy nitrates, not having used enough of the wood-ash lixivium to convert them wholly into nitrate of potash.

This is quite a strong nitre-earth, and ought to be profitable to the nitre manufacturer if properly managed. No organic matter, interfering with the purification of the nitre by the process of recrystallization, was found to be present in the lixivium from it.

The *Chemical Composition of this earth, after its soluble salts had been removed from it by thorough washing with water*, was found to be as follows:

Composition of the Washed Earth.

Organic and Volatile matters,	4.150
Alumina, and Oxides of Iron and Manganese,	12.075
Carbonate of Lime,	34.590
Magnesia,	.724
Phosphoric Acid,	1 535
Sulphuric Acid,	.852
Potash,	.649
Soda,	.223
Sand and Insoluble Silicates,	45.445
	100.243

OUACHITA COUNTY.

No. 378. "*Virgin Ouachita bottom soil, on Col. T. A. Nolan's land, Section 30, Township 12, Range 18, Ouachita County, Arkansas. Growth, white oak, water oak, large pines, beech, hickory, dogwood, and ash. Undergrowth, cane and yellow basswood. Tertiary? sandstones and shales, associated with the lignite bed.*"

The dried soil is of a dirty gray-buff color.

Extracted from 1000 *Grains of this Soil by Water charged with Carbonic Acid.*

Organic and Volatile matters,	1.407
Alumina, and Oxides of Iron and Manganese, and Phosphates,	.393
Carbonate of Lime,	.650
Magnesia,	.111
Sulphuric Acid,	.018
Potash,	.115
Soda,	——
Silica,	.130
Extract, dried at 212° F. (Grains),	2.824

The Chemical Composition of this soil, dried at 400° *F., was as follows:*

Organic and Volatile matters,	8.232
Alumina,	6.085
Oxide of Iron,	3.415
Carbonate of Lime,	.120
Magnesia,	.519
Brown Oxide of Manganese,	.395
Phosphoric Acid,	.282
Sulphuric Acid,	.075
Potash,	.207
Soda,	.078
Sand and Insoluble Silicates,	80.640
	100.048

This is quite rich soil.

Dried at 400° F., this soil lost 4.650 per cent of *Hygroscopic moisture.*

PERRY COUNTY.

No. 385. "*Virgin Soil; Mr. Joseph Y. Irvin's land, Section* 10, *Township* 5, *Range* 18 *west. Principal growth, white, red, and black oak, sweet gum, black hickory, and walnut. Perry County, Arkansas. Bottom land derived from the Millstone Grit formation.*"

The dried soil is of a light gray-brown color; contains shot-iron ore, and fragments of deep ferruginous sandstone.

No. 386. "*Soil, ten years in cultivation; Joseph Y. Irvin's land, &c. Average crop of cotton* 1200 *pounds (seed); thirty-three bushels of corn; now in cotton. Base of Millstone Grit.*"

Dried soil of a deep yellow-gray color. Some shot-iron ore sifted out.

No. 387. "*Subsoil of the same old field; Joseph Y. Irvin's land, &c. &c.*"

The dried soil is of a gray-buff color.

Extracted from 1000 *Grains of each of these Soils, by Digestion for a Month in Water charged with Carbonic Acid Gas.*

	No. 385. Virgin Soil.	No. 386. Old field Soil.	No. 387. Subsoil.
Organic and Volatile matters,	1.217	0.817	0.317
Alumina, and Oxides of Iron and Manganese, and Phosphates,	.427	.063	.093
Carbonate of Lime,	2.163	.630	.220
Magnesia,	.384	.048	.128
Sulphuric Acid,	.113	.036	.027
Potash,	.138	.119	.061
Soda,	.035	.033	.081
Silica,	.143	.230	.163
Extract, dried at 212° F.,	4.620	1.976	1.090

The Chemical Composition of these soils, dried at 400° *F., was found to be as follows:*

	No. 385. Virgin Soil.	No. 386. Old field Soil.	No. 387. Subsoil.
Organic and Volatile matters,	4.505	3.117	2.056
Alumina,	2.310	2.785	3.985
Oxide of Iron,	2.840	1.635	2.365
Carbonate of Lime,	.430	.220	.095
Magnesia,	.658	.353	.306
Brown Oxide of Manganese,	.245	.220	.220
Phosphoric Acid,	.178	.160	.159
Sulphuric Acid,	.067	.058	.045
Potash,	.149	.106	.140
Soda,	.034	.058	.050
Sand and Insoluble Silicates,	88.915	91.715	90.940
Total,	100.331	100.427	100.361
Moisture, dried at 400° F.,	2.900	2.175	2.000

The soil of the old field shows signs of deterioration.

No. 388. "*Virgin Soil from William C. Stout's plantation, bottom land, on the Arkansas River, foot of Petit Jean Mountain, Perry County, Arkansas. Nearest rock formation Millstone Grit.*"

The dried soil is of a gray-brown color. Contained much fine sand in clear grains.

No. 389. "*Same Soil from a field forty years in cultivation, now in oats. Arkansas River bottom; Wm. C. Stout's plantation, foot of Petit Jean Mountain, &c.*"

The dried soil resembles the preceding, very slightly lighter.

No. 390. "*Subsoil from nine inches to one foot below the surface; Wm. C. Stout's plantation, &c. &c.*"

The dried soil a little more brown than the preceding.

Extracted from 1000 *Grains of each of these Soils by Digestion in Carbonated Water.*

	No. 388. Virgin Soil.	No. 389. Old field Soil.	No. 390. Subsoil.
Organic and Volatile matters,	0.650	0.417	0.350
Alumina, and Oxides of Iron and Manganese, and Phosphates,	2.270	.260	.253
Carbonate of Lime,	2.270	.563	.630
Magnesia,	.250	.117	.133
Sulphuric Acid,	.033	.018	.027
Potash,	.142	.096	.088
Soda,	.052	.034	.042
Silica,	.330	.213	.230
Extract, dried at 212° F.,	3.987	1.718	1.753

The Chemical Composition of these soils, dried at 400° F., is as follows:

	No. 388. Virgin Soil.	No. 389. Old field Soil.	No. 390. Subsoil.
Organic and Volatile matters,	1.747	1.707	2.050
Alumina,	1.435	.535	.610
Oxide of Iron,	1.200	1.310	1.535
Carbonate of Lime,	.720	.370	.395
Magnesia,	.415	.472	.633
Brown Oxide of Manganese,	.080	.120	.120
Phosphoric Acid,	.191	.181	.179
Sulphuric Acid,	.036	.050	.041
Potash,	.143	.186	.206
Soda,	.048	.056	.038
Sand and Insoluble Silicates,	94.565	94.515	93.315
Loss,	——	.498	.678
Total,	100.580	100.000	100.000
Moisture, expelled at 400° F.,	1.250	1.365	2.050

The first set of Perry County soils is rather the richer. In both the soil of the old field is less rich than the virgin soil. The subsoil does not differ materially from the latter in composition.

PIKE COUNTY.

No. 372. "*Virgin Soil from David Holcomb's farm, Section* 4, *Township* 8, *Range* 26, *on a branch of Bacon Creek, over the Cretaceous Limestone, with small spiral shells. Principal growth, white oak. Pike County, Arkansas.*"

The dried soil is of a gray-umber color. Some large rounded quartzose pebbles were sifted out of it with the coarse sieve.

No. 373. "*Same Soil from David Holcomb's farm, thirty to forty years in cultivation, &c.*"

The dried soil is of a dirty gray-buff color. Some large rounded quartzose pebbles were sifted out of it.

No. 374. "*Subsoil from the same old field, &c. &c.*"

The dried soil is of a light gray-buff color. Some small rounded quartzose pebbles were sifted out of it.

Extracted from 1000 *Grains of each of these Soils, by Digestion for a Month in Water charged with Carbonic Acid Gas.*

	No. 372. Virgin Soil.	No. 373. Old field Soil.	No. 374. Subsoil.
Organic and Volatile matters,	1.473	0.500	0.233
Alumina, and Oxides of Iron and Manganese, and Phosphates,	.643	.260	.077

	No. 372. Virgin Soil.	No. 373. Old field Soil.	No. 374. Subsoil.
Carbonate of Lime,	2.843	.643	.360
Magnesia,	.108	.100	.203
Sulphuric Acid,	.027	.027	.027
Potash,	.093	.118	.054
Soda,	.037	.035	.035
Silica,	.143	.273	.160
Extract, dried at 212° F. (Grains),	5.367	1.956	1.149

The Chemical Composition of these three soils, dried at 400° *F., was found to be as follows:*

	No. 372. Virgin Soil.	No. 373. Old field Soil.	Subsoil.
Organic and Volatile matters,	8.446	2.329	1.775
Alumina,	2.735	1.360	2.560
Oxide of Iron,	1.495	1.240	2.015
Carbonate of Lime,	.645	.170	.095
Magnesia,	.562	.395	.283
Brown Oxide of Manganese,	.295	.120	.370
Phosphoric Acid,	.163	.062	.115
Sulphuric Acid,	.092	.050	.041
Potash,	.155	.101	.120
Soda,	.035	.021	.057
Sand and Insoluble Silicates,	85.915	93.965	92.765
Loss,	——	.187	——
Total,	100.538	100.000	100.196
Moisture, expelled at 400° F.,	4.100	1.250	1.425

The very much greater proportions of *Organic and Volatile matters* and *Carbonate of Lime* in the virgin soil caused the "Extract" from that, by the carbonated water, to be much more than that from the old field soil. The analysis of the latter shows also a great diminution in all the other essential ingredients, and an increase of *sand*, &c. Its affinity for *moisture* is seen also to be greatly less than that of the virgin soil. A part of this deterioration is doubtless the result of the thirty to forty years' cultivation, and a part, probably, to some admixture of the subsoil, which seems to be poorer than the original surface soil in this locality.

POINSETT COUNTY.

No. 243. "*Post Oak and Hickory Soil; Cache Swamp Soil. Quaternary deposits. Poinsett County, Arkansas.*"

The dried soil is of a buff-gray color. It is in a very fine state of division.

Chemical Composition of this Soil, dried at 400° F.

Organic and Volatile matters,	2.878
Alumina,	3.265
Oxide of Iron,	3.290
Carbonate of Lime,	.181
Magnesia,	.333
Brown Oxide of Manganese,	.095
Phosphoric Acid,	.104
Sulphuric Acid,	.012
Potash,	.108
Soda,	.105
Sand and Insoluble Silicates,	90.595
Total,	100.996
Moisture, expelled at 400° F., per cent,	1.000

POLK COUNTY.

No. 363. "*Virgin Soil, from Philip Cagle's land, Section 33, Township 2 south, Range 30 west. Red land. Growth, red, black, white, and post-oak, dogwood, black walnut, wild cherry, yellow pine, red elm, and hickory. (Millstone Grit, crystalline sandstones and shales, with bands of black flint.) Polk County, Arkansas.*"

The dried soil is of a gray-brown color; contains chiefly fragments.

No. 364. "*Same Soil twelve years in cultivation; Philip Cagle's land, &c. &c.*"

The dried soil is of a gray-brown color, a little lighter and more yellowish than the preceding. It contains a few cherty fragments.

No. 365. "*Subsoil of the same old field; Philip Cagle's land, &c.*"

The dried soil is of a brown-buff color. It contains fragments of chert; less than in the preceding.

Extracted from 1000 Grains of each of these Soils, by Digestion in Water charged with Carbonic Acid Gas.

	No. 363. Virgin Soil.	No. 364. Old field Soil.	No. 365. Subsoil.
Organic and Volatile matters,	1.900	0.800	0.483
Alumina, and Oxides of Iron and Manganese, and Phosphates,	.493	.177	.143
Carbonate of Lime,	1.817	1.730	.797
Magnesia,	.136	.216	.216
Sulphuric Acid,	.039	.037	.027
Potash,	.148	.115	.052
Soda,	.171	.048	.045
Silica,	.197	.230	.163
Loss,	.799*	.347	——
Extract, dried at 212° F. (Grains),	5.700	3.700	1.926

* Portion lost by upsetting beaker.

The Chemical Composition of these soils, dried at 400° F., was found, by analysis, to be as follows:

	No. 363. Virgin Soil.	No. 364. Old field Soil.	No. 365. Subsoil.
Organic and Volatile matters,	6.343	3.953	3.322
Alumina,	5.200	5.485	6.110
Oxide of Iron,	3.515	3.240	3.690
Carbonate of Lime,	.240	.440	.145
Magnesia,	.419	.698	.572
Brown Oxide of Manganese,	.220	.370	.395
Phosphoric Acid,	.247	.211	.194
Sulphuric Acid,	.062	.066	.058
Potash,	.193	.229	.328
Soda,	.023	.060	.069
Sand and Insoluble Silicates,	83.765	85.315	81.990
Loss,	——	——	.127
Total,	100.227	100.067	100.000
Moisture, expelled at 400° F.,	4.225	3.725	2.925

The subsoil contains a much larger proportion of *Potash* than the surface soil; and to the influence of the subsoil, and probably some admixture of it with the surface soil of the old field by the use of the plough, may we attribute the larger percentage of this alkali in the latter than in the virgin soil. In other respects the soil of the old field is inferior in richness to the virgin soil.

These are quite good lands, although not as rich as some from this State.

POPE COUNTY.

No. 315. "*Virgin Soil; J. P. Langford's farm, six miles north of Dover, Illinois Bayou. Timber large. Growth, post, black, red, and white oak, and some hickory. Pope County, Arkansas.*"

The dried soil is of a light grayish-umber color.

No. 316. "*Soil more than fifteen years in cultivation; J. P. Langford's farm, &c.*"

The dried soil is of a dirty-buff color.

No. 317. "*Subsoil of the same old field; J. P. Langford's farm, &c.*"

The dried soil is of a purer buff color than the preceding.

Extracted from 1000 *Grains of each of these Soils, Digested for a Month in Water charged with Carbonic Acid.*

	No. 315. Virgin Soil.	No. 316. Old field Soil.	No. 317. Subsoil.
Organic and Volatile matters,	0.617	0.195	0.273
Alumina, and Oxides of Iron and Manganese, and Phosphates,	.113	.080	.063
Carbonate of Lime,	.297	.497	.281

	No. 315. Virgin Soil.	No. 316. Old field Soil.	No. 317. Subsoil.
Magnesia,	.119	.066	.067
Sulphuric Acid,	.022	.025	.033
Potash,	.018	.109	.125
Soda,	.220	.015	.022
Silica,	.081	.114	.214
Loss,	——	.272	.072
Extract, dried at 400° F. (Grains),	1.517	1.283	1.150

These soils give up a moderate amount of soluble matter to the water charged with carbonic acid.

The Chemical Composition of these soils, dried at 400° *F.*, was found, on analysis, to be as follows:

	No. 315. Virgin Soil.	No. 316. Old field Soil.	No. 317. Subsoil.
Organic and Volatile matters,	4.212	3.581	2.398
Alumina,	2.985	1.860	3.085
Oxide of Iron,	1.980	3.255	3.050
Carbonate of Lime,	.120	.110	.110
Magnesia,	.306	.239	.263
Brown Oxide of Manganese,	.145	.320	.195
Phosphoric Acid,	.112	.213	.178
Sulphuric Acid,	.041	.033	.033
Potash,	.116	.130	.149
Soda,	.023	.036	.047
Sand and Insoluble Silicates,	90.395	89.670	90.310
Loss,	——	.553	.182
Total,	100.435	100.000	100.000
Moisture, expelled at 400° F.,	2.675	2.275	2.075

The soil of the old field contains a larger quantity of *Oxides of Iron and Manganese, Phosphoric Acid and Potash,* and less *Sand,* &c., than the virgin soil.

PRAIRIE COUNTY.

No. 321. "*Virgin Soil; John Percifield's place, seven miles east of Brownsville, Grand Prairie, Prairie County, Arkansas. Millstone Grit formation, locally covered with Quaternary.*"

The dried soil is of a light-umber color.

No. 322. "*Same Soil fifteen years or more in cultivation, now in corn; John Percifield's place, &c. &c.*"

Dried soil light-umber colored; lighter and more yellowish than the preceding.

No. 323. "*Subsoil of the same land, &c.*"
Dried soil still lighter and more yellowish than the preceding.

Extracted from 1000 *Grains of each of these Soils, by Digestion for a Month in Water charged with Carbonic Acid.*

	No. 321. Virgin Soil.	No. 322. Old field Soil.	No. 323. Subsoil.
Organic and Volatile matters,	0.517	0.450	0.300
Alumina, and Oxides of Iron and Manganese, and Phosphates,	.031	.197	.081
Carbonate of Lime,	a trace.	.197	.097
Magnesia,	.116	.159	.113
Sulphuric Acid,	.079	.017	.039
Potash,	.037	.183	.056
Soda,	.023	.093	.015
Silica,	.197	.064	.094
Loss,	.230	.027	——
Extract, dried at 212° F. (Grains),	1.230	1.417	0.795

The Chemical Composition of these soils, dried at 400° *F., was found to be as follows:*

	No. 321. Virgin Soil.	No. 322. Old field Soil.	No. 323. Subsoil.
Organic and Volatile matters,	4.653	2.491	2.138
Alumina,	1.725	2.090	1.515
Oxide of Iron,	1.665	1.565	2.015
Carbonate of Lime,	.046	.046	.046
Magnesia,	.280	.247	.265
Brown Oxide of Manganese,	.295	.180	.195
Phosphoric Acid,	.146	.079	.128
Sulphuric Acid,	.055	.050	.041
Potash,	.053	.143	.127
Soda,	.035	.013	.026
Sand and Insoluble Silicates,	90.020	93.080	92.330
Loss,	1.027	.016	1.174
Total,	100.000	100.000	100.000
Moisture, expelled at 400° F.,	3.300	1.675	1.825

The analysis of these soils exhibits but a very small proportion of *Carbonate of Lime* in them. It is probable, therefore, that applications of lime or calcareous marls would be beneficial in their cultivation.

PULASKI COUNTY.

No. 312. "*Virgin Soil, J. W. Purdon's farm, eight miles north of Little Rock. Growth, black and post oak, and some hickory. Pulaski County, Arkansas. Sandstone of the Millstone Grit formation.*"

The dried soil is of a dark, dirty gray-buff color.

No. 313. "*Soil from a field seventeen years in cultivation; J. W. Purdon's farm, &c.*"

Dried soil a little lighter colored than the preceding. Some small sandy ferruginous concretions or fragments were sifted out of it with the coarse sieve.

No. 314. "*Subsoil, J. W. Purdon's farm, &c.*"

Dried soil of a gray-buff color. Some small sandy ferruginous concretions or fragments were sifted out of it.

Extracted by Digestion for a Month in Water charged with Carbonic Acid.

	No. 312. Virgin Soil.	No. 313. Old field Soil.	No. 314. Subsoil.
Organic and Volatile matters,	0.483	0.300	0.334
Alumina, and Oxides of Iron and Manganese, and Phosphates,	.063	.030	.163
Carbonate of Lime,	.114	.031	.141
Magnesia,	.094	.250	.147
Sulphuric Acid,	.028	.025	.022
Potash,	.038	.035	.029
Soda,	.004	---	.008
Silica,	.131	.281	.064
Loss,	——	.148	——
Extract, dried at 212° F. (Grains),	0.955	1.100	0.908

The Chemical Composition of these three soils, dried at 400° *F.*, was found to be as follows:

	No. 312. Virgin Soil.	No. 313. Old field Soil.	No. 314. Subsoil.
Organic and Volatile matters,	2.763	2.770	2.354
Alumina,	1.275	2.390	3.455
Oxide of Iron,	2.190	1.340	2.265
Carbonate of Lime,	.070	.095	.035
Magnesia,	.219	.197	.253
Brown Oxide of Manganese,	.145	.120	.096
Phosphoric Acid,	.063	.085	.063
Sulphuric Acid,	.027	.027	.033
Potash,	.058	.087	.093
Soda,	.015	.034	.081
Sand and Insoluble Silicates,	93.415	92.395	90.910
Loss,	——	.460	.363
Total,	100.300	100.000	100.000
Moisture, expelled at 400° F.,	2.275	1.700	1.665

The soil of the old field appears to be somewhat richer than the virgin soil. The subsoil does not differ materially from the surface soil.

No. 397. "*Virgin soil, from Dr. G. G. Haliburton's land, Section* 7, *Town-*

ship 1 *south, Range* 13 *west. Growth, sweet gum, elm, water oak, water beech, lime, black hickory, and ironwood. Pulaski County, Arkansas. Crystalline schists of the Millstone Grit, overlaid locally by Tertiary limestone."*

The dried soil is of a gray-umber color.

No. 398. "*Same Soil from a field eight years in cultivation; Dr. G. G. Haliburton's farm, &c. &c."*

Dried soil gray-umber colored, a little lighter than the preceding.

No. 399. "*Subsoil of the same, &c. &c."*

Dried soil lighter colored and more yellowish than the preceding. Some rounded fragments of red ferruginous sandstone (or sandy ferruginous concretions) were sifted out of it with the coarse sieve.

Extracted from 1000 *Grains of each of these Soils, by Digestion for a Month in Water charged with Carbonic Acid Gas.*

	No. 397. Virgin Soil.	No. 398. Old field Soil.	No. 399. Subsoil.
Organic and Volatile matters,	1.133	0.600	0.583
Alumina, and Oxides of Iron and Manganese, and Phosphates,	1.167	.227	.210
Carbonate of Lime,	2.363	1.497	1.363
Magnesia,	.255	.161	.112
Sulphuric Acid,	.030	.027	.033
Potash,	.073	.093	.109
Soda,	.023	.046	.014
Silica,	.363	.263	.230
Loss,	.260	——	——
Extract, dried at 400° F. (Grains),	5.667	2.914	2.654

The Chemical Composition of these soils, dried at 400° *F.*, was found, by analysis, to be as follows:

	No. 397. Virgin Soil.	No. 398. Old field Soil.	No. 399. Subsoil.
Organic and Volatile matters,	5.438	5.191	3.491
Alumina,	2.835	3.135	3 820
Oxide of Iron,	1.915	1.790	1.915
Carbonate of Lime,	.445	.495	.205
Magnesia,	.862	.758	1.003
Brown Oxide of Manganese,	.140	.[illegible]90	.320
Phosphoric Acid,	.245	.234	.242
Sulphuric Acid,	.091	.075	.068
Potash,	.232	.256	.285
Soda,	.044	.030	.068
Sand and Insoluble Silicates,	87.290	87.415	80.240
Loss,	.463	.331	——
Total,	100 000	100.000	100.657
Moisture, expelled at 400 F.,	3.475	3.200	2.600

The subsoil is a little richer in *Potash*, and contains a little more *Alumina*, *Magnesia*, and *Oxide of Manganese*, and a little less *Carbonate of Lime*, than the surface soil, but in other respects does not differ much from it. The eight years' cultivation has not materially altered the composition of the soil of the old field, except, perhaps, by the admixture with it of a little of the subsoil.

No. 400. "*Virgin Granite Soil, adjoining George Pile's farm, near the eastern slope of the Granite range of Fourche, near the north line of Section* 4, *Township* 1 *south, Range* 12 *west, Pulaski County, Arkansas. Growth, red oak, white oak, dogwood, black hickory, pignut hickory, and maple.*"

The dried soil is of a light gray-umber color. Some small fragments of decomposing granite were sifted out of it.

No. 401. "*Same Granite Soil from an old field, twenty-six years in cultivation, chiefly in corn and oats. George Pile's farm, &c. &c.*"

The dried soil is brownish-gray, much lighter colored than the preceding.

No. 402. "*Subsoil from the same old field. George Pile's farm, &c. &c.*"

Dried soil brownish-gray, lighter colored than the preceding.

No. 403. "*Underclay from a band close to the same old field. George Pile's farm, &c. &c.*"

Dried clay of a light brickdust color; sandy, and containing spangles of mica.

Extracted from 1000 *Grains of each of these Soils, by Digestion for a Month in Water charged with Carbonic Acid Gas.*

	No. 400. Virgin Soil.	No. 401. Old field Soil.	No. 402. Subsoil.	No. 403. Underclay.
Organic and Volatile matters,	0.917	0.533	0.257	0.283
Alumina, and Oxides of Iron and Manganese, and Phosphates,	.410	.277	.127	.043
Carbonate of Lime,	1.347	1.163	.713	.447
Magnesia,	.094	.133	.078	.241
Sulphuric Acid,	.016	.039	.023	.039
Potash,	.060	.132	.100	.077
Soda,	.021	.066	.027	.045
Silica,	.263	.173	.230	.387
Loss,	——	.084	.135	——
Extract, dried at 212° F. (Grains),	3.128	2.600	1.690	1.565

The Chemical Composition of these soils, dried at 400° *F.*, was found, by analysis, to be as follows:

	No. 400. Virgin Soil.	No. 401. Old field Soil.	No. 402. Subsoil.	No. 403. Underclay.
Organic and Volatile matters,	4.577	3.131	2.524	8.326
Alumina,	3.860	3.285	4.635	21.365
Oxide of Iron,	4.300	4.090	4.390	7.650
Carbonate of Lime,	.385	.245	.220	.220

	No. 400. Virgin Soil.	No. 401. Old field Soil.	No. 402. Subsoil.	No. 403. Underclay.
Magnesia,	.426	.378	.489	1.266
Brown Oxide of Manganese,	.265	.190	.140	.140
Phosphoric Acid,	.128	.136	.143	.189
Sulphuric Acid,	.055	.050	.041	.015
Potash,	.208	.208	.227	.347
Soda,	.065	.065	.061	.384
Sand and Insoluble Silicates,	85.811	88.290	87.340	60.515
Total,	100.080	100.068	100.210	100.447
Moisture, expelled at 400° F.,	2.775	1.775	1.950	5.675

These soils are quite rich and ought to be fertile if well drained, &c. The soil of the old field seems to have been sustained, especially in those essential ingredients *Phosphoric Acid* and *Potash*, by some admixture with the subsoil. The underclay contains a large proportion of *Alumina* and *Potash*, and might be applied with advantage as a top-dressing to poor sandy soils.

RANDOLPH COUNTY.

No. 258. "*Virgin Soil; Mr. Proudfit's farm, Range 4, Section —, eighteen miles from Pocahontas, Randolph County, Arkansas. Growth, black walnut, large white and black oak, white and black gum. Lower Silurian period.*"

The dried soil is of a gray-brown color.

No. 259. "*Same Soil from an old field, more than twenty years in cultivation. Mr. Proudfit's farm, &c.*"

The dried soil is a little lighter colored and more yellowish than the preceding.

No. 260. "*Subsoil of the same old field, &c. &c.*"

The dried soil is of a gray-buff color.

Extracted from 1000 *Grains of each of these Soils, by Digestion for a Month in Water charged with Carbonic Acid Gas.*

	No. 258. Virgin Soil.	No. 259. Old field Soil.	No. 260. Subsoil.
Organic and Volatile matters,	1.250	1.300	0.400
Alumina, and Oxide of Iron and Manganese, and Phosphates,	.264	.240	.131
Carbonate of Lime,	2.830	2.780	.730
Magnesia,	.180	.194	.188
Sulphuric Acid,	.010	.010	.021
Potash,	.190	.272	.071
Soda,	.149	.051	.047
Silica,	.214	.181	.200
Loss,	——	.135	——
Extract, dried at 212° F. (Grains),	5.087	5.166	1.788

The Chemical Composition of these soils, dried at 400° *F.*, was found to be as follows:

	No. 258. Virgin Soil.	No. 259. Old field Soil.	No. 260. Subsoil.
Organic and Volatile matters,	3 485	3.395	2.105
Alumina,	2.390	2.515	3.090
Oxide of Iron,	1.610	1.910	2.410
Carbonate of Lime,	.371	.371	.246
Magnesia,	.630	.475	.371
Brown Oxide of Manganese,	.230	.230	.295
Phosphoric Acid,	.160	.152	.094
Sulphuric Acid,	.042	.033	.030
Potash,	.183	.251	.289
Soda,	.045	.100	.115
Sand and Insoluble Silicates,	91.070	90.535	90.230
Loss,	——	.033	.725
Total,	100.216	100.000	100.000
Moisture, expelled at 400° F.,	1.725	1.625	1.425

The soil of the old field is yet, in most respects, as rich as the virgin soil. It appears to have been mixed somewhat with the subsoil in the course of cultivation.

SALINE COUNTY.

No. 335. "*Virgin Soil; Mr. C. H. Richards' land, second bottom, north fork of Saline River, Section* 16, *Township* 1 *south, Range* 15 *west, Saline County, Arkansas. Primitive growth, large white, red, and black oak, sweet and black gum, elm, hickory, and some buttonwood. (Metamorphosed Millstone Grit.)*"

The dried soil is of a light umber-color.

No. 336. "*Same Soil from C. H. Richards' farm, fifteen to twenty years in cultivation, &c. &c.*"

Dried soil lighter colored and more yellowish than the preceding.

No. 337. "*Subsoil of the old field, &c. &c.*"

Dried soil of a dark dirty-buff color.

Extracted from 1000 *Grains of each of these Soils by Digestion for a Month in Water charged with Carbonic Acid Gas.*

	No. 335. Virgin Soil.	No. 336. Old field Soil.	No. 337. Subsoil.
Organic and Volatile matters,	1.433	0.683	0.267
Alumina, and Oxides of Iron and Manganese, and Phosphates,	.306	.243	.097
Carbonate of Lime,	2.027	2.117	.860
Magnesia,	.222	.235	.289
Sulphuric Acid,	.027	.027	.022
Potash,	.052	.058	.022
Soda,	.019	.023	.008
Silica,	.247	.200	.197
Loss,	.284	.324	——
Extract, dried at 212° F. (Grains),	4.617	3 910	1.762

The Chemical Composition of these soils, dried at 400° *F.*, was found, by analysis, to be as follows:

	No. 335. Virgin Soil.	No. 336. Old field Soil.	No. 337. Subsoil.
Organic and Volatile matters,	5.460	3.905	2.451
Alumina,	3.535	2.835	1.185
Oxide of Iron,	2.490	1.915	5.265
Carbonate of Lime,	.440	.415	.165
Magnesia,	.817	.708	.462
Brown Oxide of Manganese,	.240	.240	.270
Phosphoric Acid,	.163	.280	.182
Sulphuric Acid,	.124	.058	.058
Potash,	.309	.203	.212
Soda,	.076	.042	.073
Sand and Insoluble Silicates,	85.940	89.645	89.990
Loss,	.406	——	——
Total,	100.000	100.246	100.313
Moisture, expelled at 400° F.,	3.850	2.700	2.100

These soils are quite rich in the elements of vegetable food. The soil of the old field shows evident signs of deterioration by its twenty years' cultivation. The subsoil is no richer than the surface soil, except in Oxide of Iron.

SCOTT COUNTY.

No. 345. "*Virgin Soil; bottom land on Poteau River. Dr. James H. Smith's farm, Section* 15, *Township* 3, *Range* 30 *west. Growth, mulberry, black walnut, box elder, white hickory, hackberry, pawpaw, spicewood, black oak, sweet gum, and large grape vines. Shales and sandstone of the Millstone Grit. Scott County, Arkansas.*"

Dried soil of a gray-brown color.

No. 346. "*Same Soil* (*or probably a shade inferior to the virgin soil*), *from Dr. James H. Smith's farm, &c., twenty-five years in cultivation, mostly in corn; land now idle.*"

The dried soil is lighter colored and more yellowish than the preceding.

No. 347. "*Subsoil of the same old field, &c.*"

Dried soil of a dirty-buff color.

Extracted from 1000 Grains of each of these Soils, by Digestion for a Month in Water charged with Carbonic Acid Gas.

	No. 345. Virgin Soil.	No. 346. Old field Soil.	No. 347. Subsoil.
Organic and Volatile matters,	1.433	0.500	0 817
Alumina, and Oxides of Iron and Manganese, and Phosphates,	.543	.127	.110

	No. 345. Virgin Soil.	No. 346. Old field Soil.	No. 347 Subsoil
Carbonate of Lime,	4.260	.910	.727
Magnesia,	.194	.150	.143
Sulphuric Acid,	.025	.027	.030
Potash,	.108	.061	.049
Soda,	.106	.019	.080
Silica,	.330	.180	.233
Loss,	.234	——	——
Extract, dried at 212° F. (Grains),	7.233	1.974	2.189

The Chemical Composition of these soils, dried at 400° F., was found, by analysis, to be as follows:

	No. 345. Virgin Soil.	No. 346. Old field Soil.	No. 347 Subsoil.
Organic and Volatile matters,	7.678	2.950	2.592
Alumina,	3.385	2.535	3.610
Oxide of Iron,	3.590	2.450	3.340
Carbonate of Lime,	1.015	.315	.165
Magnesia,	.359	.263	.543
Brown Oxide of Manganese,	.345	.195	.220
Phosphoric Acid,	.163	.192	.149
Sulphuric Acid,	.075	.067	.050
Potash,	.241	.196	.220
Soda,	.049	.058	.079
Sand and Insoluble Silicates,	83.540	91.240	89.365
Total,	100.440	100.461	100.333
Moisture, expelled at 400° F.,	3.950	1.700	1.650

The soil of the old field is much poorer than the virgin soil, and gives up very much less of soluble material to the water charged with Carbonic Acid. The subsoil is not as rich as the virgin surface soil. It contains much less *Carbonate of Lime*, especially, and more *Sand and Insoluble Silicates.*

No. 360. "*Virgin Soil from L. S. Turman's land, one mile north of Waldron, Section* 17, *Township* 3 *north, Range* 21 *west. Shales of the Millstone Grit. Growth, red, white, black, and post oak, black ash, elm, wild cherry, black walnut, and dogwood. Undergrowth, white and black sumach. Scott County, Arkansas.*"

The dried soil is of a light yellowish-brown color.

No. 361. "*Soil from L. S. Turman's old field, thirteen years in cultivation, &c. &c.*"

The dried soil is more yellowish in color than the preceding.

No. 362. "*Subsoil from L. S. Turman's old field, &c.*"

Dried soil of a gray-buff color.

Extracted from 1000 *Grains of each of the air-dried Soils, by Digestion for a Month in Water charged with Carbonic Acid Gas.*

	No. 360. Virgin Soil.	No. 361. Old field Soil.	No. 362. Subsoil.
Organic and Volatile matters,	0.876	1.133	0.500
Alumina, and Oxides of Iron and Manganese, and Phosphates,	1.276	.443	.137
Carbonate of Lime,	.763	1.430	.517
Magnesia,	.294	.144	.137
Sulphuric Acid,	.027	.030	.027
Potash,	.061	.115	.038
Soda,	.032	.115	.046
Silica,	.297	.263	.147
Loss,	——	.094	——
Extract, dried at 400° F. (Grains)	3.626	3.767	1.574

The filtered infusion of the virgin soil (in the carbonated water) contained Carbonate of the Protoxide of Iron, and deposited much Oxide of Iron during evaporation.

The Chemical Composition of these soils, dried at 400° *F.*, was found, by analysis, to be as follows:

	No. 360. Virgin Soil.	No. 361. Old field Soil.	No. 362. Subsoil.
Organic and Volatile matters,	4.763	4.166	2.873
Alumina,	4.085	3.885	5.585
Oxide of Iron,	3.065	3.790	4.750
Carbonate of Lime,	.190	.215	.190
Magnesia,	.316	.307	.359
Brown Oxide of Manganese,	.145	.245	.195
Phosphoric Acid,	.261	.208	.128
Sulphuric Acid,	.050	.045	.042
Potash,	.193	.212	.227
Soda,	.037	.047	.065
Sand and Insoluble Silicates,	87.340	86.890	86.215
Total,	100.445	100.010	100.629
Moisture, expelled at 400° F.,	3.225	1.825	2.475

The soil of the old field appears to be a little richer in *Potash* than the virgin surface soil; in other respects it shows some deterioration. The subsoil is not quite as rich as either, except in *Potash*, of which it contains the most of any.

SEARCY COUNTY.

No. 294. "*Virgin Soil from the Dagger Farm, mouth of Dry Fork of Clear Creek, northwest part of Searcy County, Arkansas. Subcarboniferous Limestone formation.*"

The dried soil is of a light umber color.

No. 295. "*Same Soil from an old field seventeen years in cultivation; Dagger Farm, &c. &c.*"

The dried soil is a little lighter colored and more yellowish than the preceding. Some gravel iron ore was sifted out of it.

No. 296. "*Subsoil of the same old field, &c. &c.*"

The dried soil is of a dirty brownish-buff color.

Extracted from 1000 *Grains of each of these Soils, by Digestion for a Month in Water charged with Carbonic Acid Gas.*

	No. 294. Virgin Soil.	No. 295. Old field Soil.	No. 296. Subsoil.
Organic and Volatile matters,	0.847	0.417	0.383
Alumina, and Oxides of Iron and Manganese, and Phosphates,	.113	.097	.080
Carbonate of Lime,	.963	1.273	.913
Magnesia,	.122	.106	.099
Sulphuric Acid,	.052	.045	.041
Potash,	.125	.100	.082
Soda,	.054	.045	.054
Silica,	.097	.214	.147
Loss,	——	.169	.034
Extract, dried at 212° F. (Grains),	2.373	2.466	1.833

The Chemical Composition of these soils, dried at 400° *F.*, was found, by analysis, to be as follows:

	No. 294. Virgin Soil.	No. 295. Old field Soil.	No. 296. Subsoil.
Organic and Volatile matters,	2.933	4.662	2.919
Alumina,	1.140	3.415	3.475
Oxide of Iron,	1.320	2.185	2.410
Carbonate of Lime,	.596	.421	.196
Magnesia,	.184	.271	.364
Brown Oxide of Manganese,	.195	.479	.470
Phosphoric Acid,	.078	.195	.151
Sulphuric Acid,	.042	.042	.033
Potash,	.164	.217	.150
Soda,	.007	.043	.057
Sand and Insoluble Silicates,	92.695	87.947	89.445
Loss,	.646	.123	.330
Total,	100.000	100.000	100.000
Moisture, expelled at 400 F.,	2.000	2.950	2.425

If no mistake has been made in labelling these soils, the soil of the old field is richer and more fertile than the virgin soil. The subsoil is inferior to either. It contains, however, a little more *Alumina*, and *Oxides of Iron and Manganese* and *Magnesia* than the virgin soil, but less *Carbonate of Lime, Phosphoric and Sulphuric Acids* and *Potash.*

SEBASTIAN COUNTY.

No. 351. "*Red Sumac Virgin Prairie Soil; John Gillstrap's farm, Section* 12, *Township* 5, *Range* 31, *Hodge's Prairie; based on the shales over the coal. Sebastian County, Arkansas.*"

The dried soil is of a brown color. Some fragments of ferruginous sandstone were sifted out of it.

No. 352. "*Same Soil from an old field, twenty years in cultivation; John Gillstrap's farm, &c. &c.*"

Color of dried soil like that of preceding. Contains more fragments of ferruginous sandstone than the preceding.

No. 353. "*Subsoil of the same old field, &c.*"

The dried soil is of a brown color, more reddish than the preceding. It contains no fragments of sandstone.

Extracted from 1000 *Grains by Digestion for a Month in Water charged with Carbonic Acid Gas.*

	No. 351. Virgin Soil.	No. 352. Old field Soil.	No. 353. Subsoil.
Organic and Volatile matters,	0.733	0.773	0.390
Alumina, and Oxides of Iron and Manganese, and Phosphates,	.517	.363	.193
Carbonate of Lime,	.663	1.463	.563
Magnesia,	.230	.255	.083
Sulphuric Acid,	.031	.031	.033
Potash,	.061	.099	.047
Soda,	.045	.066	.031
Silica,	.110	.143	.120
Loss,	.077	——	.033
Extract, dried at 212° F.,	2.467	3.193	1,493

The Chemical Composition of these soils, dried at 400° *F.*, was found, by analysis, to be as follows:

	No. 351. Virgin Soil.	No. 352. Old field Soil.	No. 353. Subsoil.
Organic and Volatile matters,	3.675	5.168	4.247
Alumina,	1.235	10.300	4.510
Oxide of Iron,	4.590		6 940
Carbonate of Lime,	.145	.280	.130
Magnesia,	.420	.619	.308
Brown Oxide of Manganese,	.175	.190	.165
Phosphoric Acid,	.175	.170	.209
Sulphuric Acid,	.058	.050	.050
Potash,	.294	.195	.214
Soda,	.047	.033	.059
Sand and Insoluble Silicates,	88.990	83.440	83.240
Loss,	.196	——	——
Total,	100.000	100.445	100.072
Moisture, expelled at 400° F.,	2.025	2.300	2.300

The subsoil and soil of the old field differ from the virgin soil in containing much more *Alumina* and *Oxide of Iron.* In other respects, except in the *Organic matters*, and *Carbonate of Lime and Magnesia*, the soil of the old field shows some diminution in its essential ingredients. It is probable that a considerable portion of what is set down as *Organic and Volatile matters* in the old field soil and subsoil is merely water driven off from the Alumina and Oxide of Iron.

SEVIER COUNTY.

No. 329. "*Virgin Black Sandy Bottom Land, Red River bottom, overlying Cretaceous Formation; Col. David Hamilton's land, near Lanesport, Section* 11 *or* 12, *Fractional Township* 11, *Range* 33 *west. This is prairie land, and considered the best of the Red River country. Sevier County, Arkansas.*"

The dried soil is of a dark umber color.

No. 330. "*Same Soil from a field fifty years in cultivation; Col. Hamilton's land, &c.*"

Dried soil of a warm umber color, lighter than the preceding.

No. 331. "*Subsoil of the preceding, &c.*"

The dried soil is a little lighter colored than the preceding.

No. 332. "*Red Cotton Land, Red River bottom, overlying Cretaceous; Col. David Hamilton's farm, near Lanesport, Sevier County, Section* 12, *Fractional Township* 13, *Range* 33. *This is also an excellent cotton land, but the plant goes more to stalk and leaf than in the black sandy land. Produces best in dry seasons.*"

Extracted from 1000 *Grains of each of these Soils, by the Carbonated Water.*

	No. 329. Virgin Soil.	No. 330. Old field Soil.	No. 331. Subsoil.	No. 332. Red Soil.
Organic and Volatile matters, . .	0.900	0.633	0.373	0.567
Alumina, and Oxides of Iron and Manganese, and Phosphates, .	.130	.296	.117	.350
Carbonate of Lime, ...	4.227	1.226	.627	5.310
Magnesia, ...	.045	.296	.211	.516
Sulphuric Acid, ...	.096	.033	.040	.050
Potash, ...	.235	.109	.045	.086
Soda, ...	.068	.050	.033	.043
Silica, ...	.463	.280	.250	.397
Loss, ...	.486	——	——	.314
Extract, dried at 212° F. (Grains), .	6.650	2.923	1.696	7.633

The Chemical Composition of these soils, dried at 400° *F.*, was found to be as follows:

	No. 329. Virgin Soil.	No. 330. Old field Soil.	No. 331. Subsoil.	No. 332. Red Soil.
Organic and Volatile matters,	6.627	3 789	3.631	4.616
Alumina,	3.310	2.785	2.710	10.940
Oxide of Iron,	2.090	2.090	2.340	
Carbonate of Lime,	1.195	.320	.330	4.790
Magnesia,	.691	.562	.624	.685
Brown Oxide of Manganese,	.155	.140	.165	.265
Phosphoric Acid,	.130	.251	.256	.163
Sulphuric Acid,	.084	.079	.062	.067
Potash,	.413	.338	.352	.679
Soda,	.077	.053	.088	.132
Sand and Insoluble Silicates,	84.540	89.715	89.040	78 290
Loss,	.688	——	.402	——
Total,	100.000	100.122	100.000	100.027
Moisture, expelled at 400° F.,	3.875	2.350	7.750	4.150

These are quite rich soils, containing more than the usual proportions of *Potash, Carbonate of Lime, Sulphuric Acid, &c. &c.* The soil of the old field, although still very good, and richer than much good second-rate land, shows evident signs of deterioration, except in the proportion of *Phosphoric Acid;* some of which may, however, have been derived from the subsoil, which is quite rich in this material. The subsoil, in other respects, is not richer than the virgin soil.

The red soil owes its color to its large proportion of *Oxide of Iron.* It contains a very large amount of *Potash* and *Carbonate of Lime*, to which probably is due its peculiar influence on vegetable growth.

No. 339. "*Genuine Cretaceous Soil, collected close to where the Gryphea shell-beds of this system are tilted into an axis; on J. C. Graham's new field, Section* 2, *Fractional Township* 10, *Range* 30. *West part of Sevier County, Arkansas. On a section adjoining a salt well.*"

The dried soil is dark mouse-colored, in tenacious lumps.

Extracted by Digestion for a Month in Water charged with Carbonic Acid Gas.

Organic and Volatile matters,	0.533
Alumina, and Oxides of Iron and Manganese, and Phosphates,	.110
Carbonate of Lime,	3.443
Magnesia,	.200
Sulphuric Acid,	.033
Potash,	.051
Soda,	.021
Silica,	.147
Extract, dried at 212° F. (Grains),	4.538

The Chemical Composition of these soils, dried at 400° *F.*, was found, by analysis, to be as follows:

Organic and Volatile matters,	9.213
Alumina,	9.927
Oxide of Iron,	3.780
Carbonate of Lime,	1.940
Magnesia,	.490
Brown Oxide of Manganese,	.251
Phosphoric Acid,	.262
Sulphuric Acid,	.077
Potash,	.432
Soda,	.125
Sand and Insoluble Silicates,	73.115
Loss,	.388
Total,	100.000
Moisture, expelled at 400° F.,	7.475

This resembles the soils just described above from this county, in being very rich in all the mineral elements of vegetable food, as well as in containing a large proportion of *Organic and Volatile matters.* This must be very fertile soil if well drained, &c.

No. 366. "*Virgin Soil; Section* 12, *Township* 13, *Range* 32, *from William Holman's farm, Sevier County, Arkansas. Lies immediately over the Cretaceous Limestone. Growth, hickory, scrub haw, Osage orange. Undergrowth, swamp scrub dogwood.*"

The dried soil is dark mouse-colored, or gray-black. It contains small whitish particles, which decrepitate when the soil is heated. It effervesces strongly with acids.

No. 367. "*Same Soil from an old field eighteen years in cultivation, principally in corn, and about three years in cotton. Wm. Holman's farm, &c.*"

Soil dark umber-colored, containing numerous whitish particles like the preceding, and irregular whitish fragments of whitish limestone, some of a fibrous structure like satin-spar. Effervesced strongly with acids.

No. 368. "*Subsoil from the same old field, &c.*"

The dried soil is of a yellowish-gray color.

Extracted from 1000 *Grains of each of these Soils, by Digestion for a Month in Water charged with Carbonic Acid.*

	No. 366. Virgin Soil.	No. 367. Old field Soil.	No. 368. Subsoil.
Organic and Volatile matters,	0.707	0.433	0.400
Alumina, and Oxides of Iron and Manganese, and Phosphates,	.177	.093	.093
Carbonate of Lime,	6.643	6.527	6.927
Magnesia,	.150	.208	.100
Sulphuric Acid,	.039	.039	.039
Potash,	.056	.054	.047
Soda,	.053	.025	.041
Silica,	.330	.213	.147
Extract, dried at 212° F. (Grains),	8.155	7.592	7.794

The very large quantity of Carbonate of Lime dissolved by the carbonated water, makes the *weight* of the *extract* from these soils quite large.

The Chemical Composition of these soils, dried at 400° *F.*, is as follows:

	No. 366. Virgin Soil.	No. 367. Old field Soil.	No. 368 Subsoil
Organic and Volatile matters,	12 005	7.326	4.579
Alumina,	6.165	3.490	2.740
Oxide of Iron,	4.415	2.190	1.615
Carbonate of Lime,	36.410	66.285	79.260
Magnesia,	2.279	1.169	.702
Brown Oxide of Manganese,	.290	.240	.140
Phosphoric Acid,	.368	.147	.112
Sulphuric Acid,	.247	.170	.118
Potash,	.362	.214	.135
Soda,	.116	.085	.099
Sand and Insoluble Silicates,	37.990	19.190	10.915
Total,	100 677	100.506	100.415
Moisture, expelled at 400 F.,	9.675	4.450	2.775

These soils contain so much Carbonate of Lime, that they may be considered *marls* rather than soils. The virgin soil is very rich in *Phosphoric and Sulphuric Acids* and *Potash.* The old soil and subsoil do not contain so much, but have much more *Carbonate of Lime.* These latter might be burnt into lime for mortar or other purposes; they would be hydraulic if they contained a little more magnesia, and deserve trial in this way as it is. They would be very valuable as a top-dressing to soils which were worn out and deficient in lime, &c. &c. The only probable drawback to the great fertility of these soils is in the very large proportion of carbonate of lime, which making the water which percolates and moistens them *very hard*, by loading it with the bicarbonates of lime and magnesia, *may be* injurious to some forms of vegetable growth. It would be interesting to experiment with various vegetables in these very calcareous soils. The virgin soil is almost black from the presence of the very large proportion of Organic and Volatile matters; more than twelve per cent.

UNION COUNTY.

No. 340. "*Camp Creek Glady Soil, Section* 2, *Township* 17, *Range* 17, *near Lisbon, Union County, Arkansas. Not much cultivated. The inhabitants want to know whether it will do for cultivation. Quaternary.*"

The dried soil is mouse-colored. When calcined and the organic matters burnt out, it is of a light-gray color, indicating the almost entire absence of Oxide of Iron.

One thousand grains digested for a month in water charged with Carbonic Acid, gave up 1.456 grains *of chocolate-brown Extract*, dried at 212°, the composition of which is as follows:

Organic and Volatile matters,	0.817
Alumina, and Oxides of Iron and Manganese, and Phosphates,	.160
Carbonate of Lime,	.160
Magnesia,	.100
Sulphuric Acid,	.016
Potash,	.026
Soda,	.030
Silica,	.147
Extract, dried at 212° F. (Grains),	1.456

The Chemical Composition of this soil, dried at 400° *F., was found, by analysis, to be as follows:*

Organic and Volatile matters,	6.618
Alumina,	3.735
Oxide of Iron,	a trace.
Carbonate of Lime,	.140
Magnesia,	.208
Brown Oxide of Manganese,	a trace.
Phosphoric Acid,	.096
Sulphuric Acid,	.062
Potash,	.035
Soda,	,036
Sand and Insoluble Silicates,	90.715
Total,	101.645
Moisture, expelled at 400° F., per cent.,	3.675

The addition of *ferruginous* clays or good marl, bone-dust with wood ashes, or stable manure in abundance, would be necessary to constitute this a fertile soil. It is deficient in *Oxide of Iron*, *Oxide of Manganese*, *Phosphoric Acid* and *Alkalies*, &c. &c., whilst it contains enough of *Organic matters* to give it quite a dark color. The great deficiency of *Oxides of Iron and Manganese*, &c. &c., must be supplied from some source before it can be made productive.

No. 348. "*Virgin Soil from Section* 34, *Township* 16, *Range* 17, *from Major D. R. Coulter's farm, near Lisbon, northwestern part of Union County, Arkansas, on the waters of Camp Creek. Quaternary formation.*"

The dried soil is ash-gray or umber-gray colored. It contains much sand and some rounded quartzose pebbles.

No. 349. "*Same Soil from an old field, eighteen years in cultivation; D. R. Coulter's farm, &c. &c.*"

Contains much sand composed of rounded clear and reddish grains, and

some rounded quartzose pebbles. The dried soil is much lighter-colored than the preceding.

No. 350. "*Subsoil of the same old field, &c. &c.*"

The dried soil is of a gray-buff color; contains somewhat less sand than the preceding, and some rounded quartzose pebbles.

Extracted from 1000 *Grains of each of these Soils, by Digestion for a Month in Water charged with Carbonic Acid Gas.*

	No. 348. Virgin Soil.	No. 349. Old field Soil.	No. 350. Subsoil.
Organic and Volatile matters,	0.767	0.363	0.360
Alumina, and Oxides of Iron and Manganese, and Phosphates,	.380	.177	.177
Carbonate of Lime,	.667	.647	.343
Magnesia,	.083	.093	.105
Sulphuric Acid,	.033	.027	.027
Potash,	.040	.056	.056
Soda,	.037	.032	.050
Silica,	.217	.217	.200
Extract, dried at 212° F. (Grains),	2.224	1.612	1.318

The Chemical Composition of these soils, dried at 400° *F., was found to be as follows:*

	No. 348. Virgin Soil.	No. 349. Old field Soil.	No. 350. Subsoil.
Organic and Volatile matters,	1.893	1.055	1.674
Alumina,	.285	.685	2.935
Oxide of Iron,	.965	.640	1.865
Carbonate of Lime,	.020	.070	.070
Magnesia,	.301	.287	.893
Brown Oxide of Manganese,	.140	.115	.165
Phosphoric Acid,	.052	.061	.062
Sulphuric Acid,	.027	.041	.033
Potash,	.029	.029	.096
Soda,	.095	trace	.026
Sand and Insoluble Silicates,	95.890	97.090	92.115
Loss,	.303	——	.066
Total,	100.000	100.073	100.000
Moisture, expelled at 400° F.,	0.950	0.475	1.425

Soils containing so large a proportion of *Sand*, &c., cannot be expected to be very fertile or durable, except by the constant use of proper manures. These differ from the *glade* soil, just described, principally in containing much more *Oxide of Iron*, and less *Organic and Volatile matters*. The subsoil contains more *Potash* and less *Sand*, &c., than the surface soil. Lime, plaster of Paris, wood ashes, bone-dust, superphosphate, or guano, may be advantageously employed on these soils.

VAN BUREN COUNTY.

No. 279. "*Virgin Soil from George More's farm. Waters of the Cadron. Growth, black and post oak. Undergrowth, sumach. True oak land. Van Buren County, Arkansas. Millstone Grit formation.*"

The dried soil is of a light clove-brown color.

No. 280. "*Same Soil from George More's farm, eleven years in cultivation. Upland and table land soil, &c.*"

The dried soil is of a gray-brown color, lighter than the virgin soil.

No. 281. "*Subsoil from the same old field; George More's farm, &c. &c.*"

The dried soil is lighter colored and more reddish than the preceding.

One thousand Grains of each of these Soils, Digested for a Month in Water charged with Carbonic Acid, gave up the following materials:

	No. 279. Virgin Soil.	No. 280. Old field Soil.	No. 281. Subsoil.
Organic and Volatile matters,	0.950	0.466	0.550
Alumina, and Oxides of Iron and Manganese, and Phosphates,	.140	.120	.047
Carbonate of Lime,	1.280	.896	.287
Magnesia,	.244	.105	.147
Sulphuric Acid,	.056	.056	.030
Potash,	.170	.045	.055
Soda,	——	.015	.077
Silica,	.264	.264	.064
Loss,	——	.099	.076
Extract, dried at 212° F.,	3.104	2.066	1.333

The Chemical Composition of these soils, dried at 400° *F.*, was found, by analysis, to be as follows:

	No. 279. Virgin Soil.	No. 280. Old field Soil.	No. 281. Subsoil.
Organic and Volatile matters,	5.592	2.787	2.407
Alumina,	3.440	1.840	2.515
Oxide of Iron,	3.635	3.160	1.920
Carbonate of Lime,	.196	.171	.121
Magnesia,	1.280	.201	.203
Brown Oxide of Manganese,	.245	.245	.245
Phosphoric Acid,	.237	.078	.097
Sulphuric Acid,	.038	.024	.033
Potash,	.150	.107	.096
Soda,	.007	——	.025
Sand and Insoluble Silicates,	86.300	92.470	92.120
Loss,	——	——	.218
Total,	101.120	101.083	100 000
Moisture, expelled at 400° F.,	2.550	1.350	1.325

The virgin soil is considerably richer than either the old field soil or the subsoil. These two latter resemble each other considerably in composition.

WASHINGTON COUNTY.

No. 405. "*Nitre-Earth; Cave I, near Mr. Orion Reiff's, Washington County, Arkansas.*"

An umber-colored earth, containing a few fragments of the bones of small animals (bats?), mixed with fragments of shale and coarse-grained limestone.

The air-dried earth gave up to water about 1.597 per cent of its weight of *soluble saline* matters, which, when evaporated and dried at 212° F., appeared like a yellowish-brown extract, and was found to be of the following *composition:*

Organic and Volatile matters,	0.044
Alumina,	a trace.
Lime,	.319
Magnesia,	.108
Potash,	.091
Soda,	.049
Sulphuric Acid,	.330
Chlorine,	.021
Nitric Acid,	.200—equal to 0.374 per cent of Nitre.
Silica,	.079
Water and loss,	.356
Saline matters, dried at 212° F.,	1.597 per cent.

This earth is much poorer in nitrates than Thompson's nitre-earth, described under Newton County; and, yielding only about one-third of one per cent of nitre, it is doubtful whether it would pay for the expense of working it, except on a large scale, and with very economical management. Whether the quantity found is sufficient to justify this is unknown to the writer.

The Chemical Composition of the washed earth, dried at 400° *F., was found to be as follows:*

Organic and Volatile matters, expelled at a red heat,	14.150
Alumina, and Oxides of Iron and Manganese,	8.715
Carbonate of Lime,	21.865
Magnesia,	.505
Phosphoric Acid,	1.295
Sulphuric Acid,	.196
Potash,	.553
Soda,	.207
Sand and Insoluble Silicates,	52.895
	100.381

Should this earth not prove profitable, as a source of nitre, it could be

used with great advantage as a top-dressing on land deficient in *lime, phosphoric and sulphuric acids* and *potash*, or which had become exhausted of its essential mineral elements by long culture. It has the composition of a pretty rich marl; and even the lixiviated earth could be used in this way.

No. 276. "*Virgin Soil from John Reiff's farm, Section* 31, *Township* 16, *Range* 30. *A fine sample of the red upland, overlying the Archimedes Sub-carboniferous Limestone in the central part of Washington County, Arkansas.*"

The dried soil is of a light reddish-gray brown color.

No. 277. "*Same Soil from an old field thirty-eight years in cultivation; John Reiff's farm, &c. &c.*"

The dried soil is of a light umber color, with a reddish tinge. Seems to be of a different character from the preceding.

No. 278. "*Subsoil from the same old field, &c.*"

The dried soil resembles the next preceding.

Extracted from 1000 *Grains of each of these Soils, by Digestion for a Month in Water charged with Carbonic Acid Gas.*

	No. 276. Virgin Soil.	No. 277. Old field Soil.	No. 278. Subsoil.
Organic and Volatile matters,	0.933	0.183	0.533
Alumina, and Oxides of Iron and Manganese, and Phosphates,	.296	.246	.146
Carbonate of Lime,	2.763	2.097	2.163
Magnesia,	.144	.106	.127
Sulphuric Acid,	.045	.039	.062
Potash,	.170	.131	.112
Soda,	.027	——	.003
Silica,	.264	.200	.274
Extract, dried at 212° F.,	4.642	3.302	3.420

The Chemical Composition of these Soils, dried at 400° *F., was found to be as follows:*

	No. 276. Virgin Soil.	No. 277. Old field Soil.	No. 278. Subsoil.
Organic and Volatile matters,	5.325	4.537	4.571
Alumina,	2.015	1.715	1.545
Oxide of Iron,	5.085	2.960	3.185
Carbonate of Lime,	.371	.495	.321
Magnesia,	.457	.229	.392
Brown Oxide of Manganese,	.295	.145	.495
Phosphoric Acid,	.217	.160	.118
Sulphuric Acid,	.050	.050	.050
Potash,	.433	.147	.111
Soda,	.168	.031	.025
Sand and Insoluble Silicates,	85.820	89.420	88.795
Loss,	——	.111	.392
Total,	100.236	100.000	100.000
Moisture, expelled at 400° F.,	2.735	1.925	2.100

The virgin soil is quite rich, containing more than the average proportions of the essential mineral elements. The soil of the old field contains less of all the essential ingredients (except of *Carbonate of Lime* and *Sulphuric Acid*) than the virgin soil. The subsoil is much poorer than even the surface soil of the old field.

WHITE COUNTY.

No. 300. "*Virgin Soil, from Samuel Critz's farm, eight miles west of Searcy, White County, Arkansas. Growth, black oak, red oak, black jack, mockenut-hickory, and rough bark. Derived from the ferruginous shales of the Millstone Grit formation.*"

Dried soil of a light buff-brown color. Some small fragments of ferruginous shale were sifted out of it.

No. 301. "*Same Soil from Samuel Critz's old field, twenty years in cultivation, chiefly in corn, &c.*"

Dried soil more reddish, and rather lighter colored than the preceding.

No. 302. "*Subsoil from the same old field, &c.*"

The dried soil is of a brickdust color.

Extracted from 1000 *Grains of each of these Soils, by Digestion for a Month in Water charged with Carbonic Acid Gas.*

	No. 300. Virgin Soil.	No. 301. Old field Soil.	No. 302. Subsoil.
Organic and Volatile matters,	0.400	0.600	0.683
Alumina, and Oxides of Iron and Manganese, and Phosphates,	.067	.133	.073
Carbonate of Lime,	.853	.620	.416
Magnesia,	.116	.153	.154
Sulphuric Acid,	.050	.039	.050
Potash,	.119	.106	.086
Soda,	.041	.047	.104
Silica,	.114	.081	.064
Loss,	.106	——	——
Extract, dried at 212° F. (Grains),	1.966	1.779	1.660

The Chemical Composition of these Soils, dried at 400° *F.*, was found to be as follows:

	No 300. Virgin Soil.	No. 301. Old field Soil.	No. 302. Subsoil.
Organic and Volatile matters,	4.989	3.314	2.714
Alumina,	2.215	2.215	4.375
Oxide of Iron,	3.035	2.335	2.985
Carbonate of Lime,	.220	.130	.095
Magnesia,	.418	.340	.297
Brown Oxide of Manganese,	.220	.195	.245
Phosphoric Acid,	.143	.269	.104

	No. 300. Virgin Soil.	No. 301. Old field Soil.	No. 302. Subsoil.
Sulphuric Acid,	.055	.055	.033
Potash,	.121	.145	.187
Soda,	.018	.025	.067
Sand and Insoluble Silicates,	87.860	90.245	88.845
Loss,	.706	.702	.053
Total,	100.000	100.000	100 000
Moisture, expelled at 400° F.,	2.800	2.075	2.350

Except in the *Phosphoric Acid* and *Potash*, the soil of the old field shows a diminution in all its more valuable ingredients. The subsoil is a little richer in *Potash* than the surface soil; in other respects it is not better.

YELL COUNTY.

No. 391. "*Virgin Soil from William McCray's farm, Township* 6, *Range* 21 *west*, *Section* 18, *Yell County*, *Arkansas*. *Shales of the Millstone Grit.*"

The dried soil is of a brownish-gray color.

No. 392. "*Soil twenty-one years in cultivation. Wm. McCray's farm, &c.*"

The dried soil is of a dirty yellowish-gray color.

No. 393. "*Subsoil of the same old field, &c.*"

Dried soil of a gray-buff color.

Extracted from 1000 *Grains of each of these Soils, by Digestion for a Month in Water charged with Carbonic Acid Gas.*

	No. 391. Virgin Soil.	No. 392. Old field Soil.	No. 393. Subsoil.
Organic and Volatile matters,	1.133	0.367	0.290
Alumina, and Oxides of Iron and Manganese, and Phosphates,	.583	.127	.077
Carbonate of Lime,	.797	.613	.313
Magnesia,	.269	.217	.129
Sulphuric Acid,	.033	.018	.027
Potash,	.151	.018	.061
Soda,	.015	.015	.046
Silica,	.247	.130	.130
Extract, dried at 400° F.,	3.228	1.505	1.073

The Chemical Composition of these Soils, dried at 400° *F., was found, on analysis, to be as follows:*

	No. 391. Virgin Soil.	No. 392. Old field Soil.	No. 393. Subsoil.
Organic and Volatile matters,	4.556	1.890	1.956
Alumina,	2.165	2.820	3.190
Oxide of Iron,	1.740	1.650	2.940
Carbonate of Lime,	.195	.085	.045
Magnesia,	.695	.141	.339
Brown Oxide of Manganese,	.125	.075	.115
Phosphoric Acid,	.161	.143	.208
Sulphuric Acid,	.058	.024	.033
Potash,	.149	.116	.162
Soda,	.021	.009	.072
Sand and Insoluble Silicates,	90.365	93.390	90.840
Loss,	——	——	.100
Total,	100.230	100.343	100.000
Moisture, expelled at 400° F.,	2.325	1.275	1.600

The analysis of the soil of the old field exhibits a diminution in the *Organic and Volatile matters, Carbonate of Lime, Magnesia, Oxide of Manganese, Phosphoric and Sulphuric Acids, Potash and Soda*, as well as in the *Soluble Extract* and *Hygroscopic moisture.* The subsoil contains a little more *Potash and Phosphoric Acid*, and a little less *Lime, Magnesia, and Sulphuric Acids*, than the surface soil.

IOWA, MINNESOTA, AND WISCONSIN SOILS.

For the purpose of comparison with the Arkansas soils which have been analyzed, I append a table of the results of my analysis of six soils from amongst those collected by Dr. D. D. Owen in his Northwestern explorations. See his large published "*Report of a Geological Survey of Wisconsin, Iowa, and Minnesota, &c.*" 1852.

These soils are believed to be amongst the richest of the region where they were collected.

a. "*Soil from the timbered land adjoining Prairie, Winnebago Agency, Iowa.*"

The dried soil is of a gray-umber color; it contains small rounded grains of quartz and much fine sand.

b. "*Soil, average quality, from the Prairie between Willow and Lime Creeks, Winnebago Reserve, Iowa.*"

The dried soil is of a dark-umber color; it contains small rounded quartz grains and much fine sand, with some few larger fragments of quartz and decomposing chert.

c. "*Average soil of the best land west of the west branch of the Wapipinicon, Minnesota.*"

The dried soil is umber-colored, containing small rounded quartzose grains and much fine sand.

d. "*Soil over F. 2′ (Lower Silurian Magnesian Limestone), four and a half miles northwest of Catfish Bar, Lake St. Croix, Minnesota.*"

The dried soil is umber-colored, lighter than the preceding; it contains fewer rounded quartz grains and much fine sand.

e. "*Soil, Brown's farm, fifteen miles below St. Paul's, over F. 2′ (Lower Silurian Magnesian Limestone), Wisconsin.*"

The dried soil is of a gray-umber color; principally fine sand composed of rounded grains.

f. "*Average wheat soil, between Kikapoo River and Prairie du Chien, Wisconsin.*"

Dried soil of a gray-umber color; principally fine sand, which is much finer than the preceding.

The Chemical Composition of these Soils, dried at 400° *F., is as follows:*

	a. Iowa.	b. Iowa.	c. Minnesota.	d. Minnesota.	e. Wisconsin.	f. Wisconsin
Organic and Volatile matters,	2.708	6.028	6.348	5.425	1.732	6.580
Alumina,	2.335	4.610	5.585	4.610	.335	3.285
Oxide of Iron,	1.790	3.515	3.765	3.765	1.840	2.915
Carbonate of Lime,	.315	.665	.565	.690	.425	.940
Magnesia,	.796	.855	.944	.890	.512	.647
Brown Oxide of Manganese,	.120	.120	.095	.180	.145	.145
Phosphoric Acid,	.159	.181	.237	.230	.191	.262
Sulphuric Acid,	.050	.110	.074	.093	.067	.075
Potash,	.198	.311	.299	.310	.172	.296
Soda,	.020	.097	.094	.053	.055	.083
Sand and Insoluble Silicates,	92.215	83.590	82.065	83.840	93.905	86.240
Loss,	——	——	——	——	.621	——
Total,	100.706	100.082	100.071	100.086	100.000	101.168
Moisture, expelled at 400° F.,	1.815	4.625	5.500	4.250	1.315	3.500

Time did not permit the digestion of these soils for a month in water charged with Carbonic Acid; but it is probable, from their light and sandy nature, they would have given up to it a considerable amount of *soluble matters.*

These may, without exception, be considered good soils, notwithstanding the considerable amount of fine sand which they contain; but the best of them do not quite equal in richness the *best* bottom lands of Arkansas, nor the fertile blue limestone soil of Central Kentucky.

TABLE OF THE COMPOSITION &c. OF THE SOILS.

Number.	County.	Extracted from 1000 grains by Carbonated Water.	Hygroscopic Moisture.	Organic and Volatile matters.	Alumina.	Oxide of Iron.	Carbonate of Lime.	Magnesia.	Brown Oxide of Manganese.	Phosphoric Acid.	Sulphuric Acid.	Potash.	Soda.	Sand and Insoluble Silicates.	Remarks.
333	Arkansas,	5.950	5.375	9.342	9.600		1.470	0.645	0.165	0.250	0.067	0.352	0.083	78.365	Virgin bottom soil.
334	"	3.567	5.110	6.207	5.965	4.615	1.165	1.496	.295	.194	.050	.618	.158	79.390	Cultivated soil.
369	Bradley,	3.569	2.085	3.207	2.490	2.740	.390	.405	.165	.095	.041	.121	.006	90.365	Virgin Tertiary soil.
370	"	1.927	1.125	1.643	2.290	1.790	.190	.3[illegible]4	.140	.094	.036	.085	.088	93.840	Old field soil.
371	"	0.640	3.500	2.849	6.265	3.640	.115	.417	.140	.129	.024	.164	.048	86.640	Subsoil.
375	"	3.830	4.500	6.806	5.985	15.959	.420	.413	.745	.331	.075	.328	. . .	69.690	Virgin red Tertiary soil.
376	"	2.933	4.000	5.547	5.066	23.605	.120	.604	.595	.413	.058	.227	.075	63.690	Old field red soil.
377	"	1.280	4.775	5.282	10.620	24.205	.095	.543	.495	.297	.050	.248	.067	58.098	Subsoil.
285	Benton,	3.005	1.550	2.818	.840	2.010	.096	.364	.145	.078	.024	.125	.025	92.320	Virgin Subcarboniferous soil.
286	"	2.133	1.000	1.823	.425	1.810	.096	.316	.120	.160	.024	.130	.038	93.580	Old field soil.
287	"	1.300	1.225	1.494	1.190	2.560	.046	.976	.170	.040	.016	.193	.037	92.195	Subsoil.
341	Clarke,	2.397	11.150	8.216	12.910	6.350	2.640	1.737	.370	.302	.075	.563	.111	68.315	Virgin black sticky soil.
342	"	2.574	9.865	7.443	9.010	5.600	2.215	1.356	.415	.191	.084	.396	.106	73.040	Cultivated " "
343	"	6.935	11.025	16.352	8.935	5.015	3.375	1.044	.545	.165	.144	.351	.090	64.015	Virgin Cretaceous soil.
344	"	10.896	5.575	4.961	6.735	4.650	35.950	1.306	.345	.234	.170	.454	.109	44.040	Old field " "
288	Conway,	2.139	1.800	3.207	2.625	2.210	.121	.371	.270	.127	.050	.116	.024	91.145	Virgin Millstone Grit soil.
289	"	1.316	1.050	1.895	.490	1.935	.021	.371	.195	.053	.028	.097	.012	93.720	Old field " "
290	"	1.136	1.200	1.469	3.115	2.010	.046	.236	.170	.105	.016	.140	.042	92.695	Subsoil " "
273	Crawford,	4.900	3.975	7.836	2.515	2.360	.821	1.170	.145	.164	.050	.435	.153	84.720	Virgin bottom soil.
274	"	3.973	4.000	6.404	4.240	3.785	.921	.731	.120	.261	.045	.357	.032	82.595	Old field " "
275	"	4.293	4.525	6.582	11.363		.945	.436	. . .	.213	.052	.579	.136	80.595	Subsoil " "
282	"	3.881	2.425	4.791	1.690	2.135	.221	.880	.095	.063	.033	.246	.059	88.520	Virgin sandy bottom soil.
283	"	2.925	1.650	2.460	2.795	2.085	.296	.683	.145	.145	.042	.198	.160	91.110	Old field " "
284	"	1.334	1.725	2.467	3.090	2.360	.296	.731	.220	.167	.024	.307	.059	89.895	Subsoil " "
309	"	2.100	1.625	3.176	1.690	3.490	.170	.293	.195	.176	.041	.101	.039	90.795	Virgin Millstone Grit upland soil.
310	"	1.423	1.175	1.897	2.690	1.790	.071	.293	.095	.095	.028	.120	.035	93.300	Old field " "
311	"	0.901	2.025	2.271	3.115	3.490	.096	.285	.170	.128	.013	.161	.006	89.770	Subsoil.
264	Fulton,	2.927	3.875	7.575	5.165	4.110	.680	.341	.220	.164	.084	.686	.061	79.420	Virgin Lower Silurian soil.
265	"	. . .	3.275	6.952	4.075	3.075	.396	.787	.220	.129	.059	.565	.110	83.195	Old field " "
266	"	2.383	4.200	6.341	7.240	5.360	.431	.683	.370	.165	.059	.700	.101	77.345	Subsoil " "
267	"	7.250	2.475	5.793	1.815	1.960	.396	.383	.320	.162	.050	.232	.031	88.070	Virgin Lower Silurian soil.
268	"	3.883	1.525	3.275	2.965	2.235	.171	.353	.195	.144	.050	.117	.017	90.220	Old field " "

269	"	1.550	1.100	1.794	3.265	2.860	.071	.371	.270	.078	.050	.265	.016	91.345	Subsoil " "
217	Greene,	6.623	2.300	6.243	.570	1.185	.421	.352	.120	.183	Not estimated.	.152	.050	90.045	Virgin black sand soil.
218	"	4.283	.775	2.091	.420	.710	.246	.208	.173	.115	"	.079	.048	95.600	Old field " "
219	"	1.850	.650	1.233	.395	1.010	.096	.193	.020	.078	"	.132	.048	97.995	Subsoil " "
228	"	7.666	2.065	4.825	1.490	1.485	.396	.296	.246	.259	.033	.183	.058	90.695	Virgin black sand soil.
229	"	8.350	1.825	4.405	1.165	.985	.571	.265	.171	.193	.050	.116	.058	91.670	Old field " "
230	"	1.469	4.950	4.013	15.335*		.121	.400	. . .	.283	.021	.398	.055	79.435	Red underclay.
220	"	5.410	1.725	4.000	4.745	1.660	.296	.325	.245	.259	.028	.188	.067	90.695	Virgin Quaternary soil.
221	"	5.017	1.450	3.602	1.070	1.960	.346	.404	.298	.249	.041	.162	.076	90.980	Old field " "
222	"	2.650	1.275	2.329	1.170	1.960	.271	.412	.195	.117	.041	.207	.065	91.870	Subsoil " "
223	"	4.625	2.365	5.464	1.015	1.610	.231	.205	.171	.112	.050	.147	.061	90.934	Virgin Quaternary soil.
224	"	. . .	. . .	5.229	15.819*		.284	.461	. . .	.420	. . .	1.062	.420	79.980	Silicious clay.
225	"	7.017	2.365	5.080	2.565	1.650	.431	.490	.281	.111	.050	.162	.049	89.220	Virgin Quaternary soil.
226	"	6.077	1.435	2.551	1.725	1.720	.181	.323	.271	.143	.033	.227	.080	91.645	Old field " "
227	"	3.612	1.815	2.301	3.340	2.085	.096	.537	.321	.341	.041	.304	.100	89.595	Subsoil " "
326	Hempstead,	4.941	4.875	5.387	8.235	4.235	2.415	1.142	.290	.191	.067	.314	.015	77.740	Virgin Cretaceous soil.
327	"	7.718	6.325	6.032	6.110	3.085	35.400	1.457	.240	.132	.127	.270	. . .	47.380	Old field " "
328	"	7.733	4.800	5.583	5.235	2.535	30.240	1.313	.240	.087	.093	.314	.095	35.140	Subsoil " "
338	"	1.248	0.725	1.519	1.060*		.190	.149	. . .	.094	.019	.018	.026	97.265	White sandy soil.
240	Independence,	4.433	3.625	6.874	5.440	4.270	.495	.493	.180	.230	.015	.405	.111	81.720	Virgin upland Subcarbonif. soil.
241	"	4.211	2.100	4.294	3.755	4.285	.320	.497	.130	.210	.033	.256	.116	86.020	Old field " "
242	"	1.870	2.050	3.343	4.790	4.485	.245	.561	.130	.193	.042	.372	.105	85.080	Subsoil " "
244	"	3.450	4.475	8.872	5.390	3.385	.921	.504	.220	.232	.042	.565	.202	79.970	Virgin Subcarboniferous soil.
245	"	2.550	2.885	5.744	4.715	2.985	.571	.614	.283	.291	.059	.429	.141	84.395	Old field " "
246	"	2.990	3.025	5.516	5.290	3.310	.646	.614	1.495	.229	.042	.440	.159	83.730	Subsoil " "
303	"	1.939	3.075	4.204	3.325	1.985	.245	.292	.345	.162	.045	.295	. . .	88.920	Virgin Subcarboniferous ? soil.
304	"	1.541	2.575	3.284	3.540	2.410	.220	.272	.320	.211	.033	.142	. . .	88.870	Old field soil.
305	"	1.500	2.275	2.788	2.315	2.310	.170	.280	.295	.145	.012	.207	.004	90.130	Subsoil.
324	"	1.217	4.565	3.373	3.615	6.140	.345	.250	1.270	.282	.066	.145	.156	84.080	Parroquet Bluff soil.
325	"	3.934	6.150	9.669	4.440	11.915	2.121	1.130	8.245	.368	.096	.893	.047	60.995	Manganese Lower Silurian soil.
379	"	8.083	6.275	8.242	5.610	3.140	1.220	.539	.090	.372	.110	.406	.111	80.265	Virgin White River bottom soil.
380	"	5.303	5.400	7.145	5.410	3.815	1.165	.550	.165	.328	.106	.416	.100	80.840	Old field " "
381	"	2.140	4.450	4.421	4.460	4.350	.695	.521	.190	.298	.058	.376	.095	83.975	Subsoil " "
382	"	10.172	2.400	3.483	2.310	2.490	2.570	.667	.180	.193	.072	.327	.088	87.215	Vir. White R. bot. soil on Subcarb
383	"	3.283	2.800	3.916	3.560	2.690	.610	.583	.290	.212	.101	.263	.090	88.490	Old field " "
384	"	1.900	2.075	1.914	2.810	2.115	.315	.356	.115	.209	.050	.207	.104	91.590	Subsoil " "
270	Izard,	2.300	1.465	3.673	2.065	1.290	.071	.285	.070	.104	.021	.156	.055	91.815	Virgin Lower Silurian soil.
271	"	1.934	0.725	1.838	1.015	.790	.146	.299	.015	.062	.016	.145	.013	95.270	Old field " "
272	"	1.378	.875	1.705	2.290	1.165	.096	.296	.145	.095	.011	.198	.019	93.880	Subsoil " "
231	Jackson,	7.323	2.875	4.759	2.725	1.865	.471	.408	.320	.294	.033	.306	.035	88.620	Virgin black sand soil.
232	"	8.188	2.650	4.905	2.175	1.915	.593	.473	.330	.408	.059	.295	.032	88.445	Old field " "

* And oxide of manganese.

TABLE OF SOILS, &c.—*Continued.*

Number.	County.	Extracted from 1000 grains by Carbonated Water.	Hygroscopic Moisture.	Organic and volatile matters.	Alumina.	Oxide of Iron.	Carbonate of Lime.	Magnesia.	Brown Oxide of Manganese.	Phosphoric Acid.	Sulphuric Acid.	Potash.	Soda.	Sand and Insoluble Silicates.	Remarks.
233	Jackson,	2.669	1.700	1.983	2.190	2.065	0.296	0.425	0.145	0.192	0.045	0.295	0.058	91.630	Subsoil black sand soil.
234	"	3.166	1.175	1.796	1.940	1.190	.196	.308	.220	.094	.033	.140	.042	94.015	Virgin Quaternary soil.
235	"	3.483	.850	1.654	1.275	1.225	.246	.221	.095	.143	.033	.135	.055	94.680	Old field " "
236	"	1.489	.825	1.185	1.805	1.365	.221	.302	.130	.114	.045	.130	.023	94.770	Subsoil " "
237	"	1.633	.925	1.993	.890	1.365	.245	.665	.070	.110	.022	.120	not est.	93.995	Virgin Quaternary soil.
238	"	1.301	1.100	2.047	.615	1.440	.320	.244	.095	.112	.028	.096	.005	94.345	Old field " "
239	"	1.288	.800	1.260	1.990	1.440	.260	.261	.070	.126	.025	.072	.059	94.345	Subsoil " "
318	Johnson,	0.950	2.000	3.316	1.910	3.050	.045	.279	.145	.174	.033	.092	.024	90.545	Virgin Millstone Grit soil.
319	"	1.331	2.100	3.294	3.485	2.755	.170	.271	.180	.128	.038	.044	.122	89.445	Old field " "
320	"	0.783	2.000	4.147	5.110	3.330	.070	.382	.270	.095	.033	.273	.014	86.857	Subsoil " "
394	"	3.117	1.675	3.254	1.240	1.715	.205	.546	.100	.208	.058	.166	.065	92.240	Virgin Millstone Grit soil.
395	"	3.633	1.475	2.892	1.840	1.615	.295	.314	.190	.159	.055	.171	.034	92.865	Old field " "
396	"	1.617	1.675	2.034	1.840	3.190	.160	.314	.190	.143	.023	.200	.058	91.415	Subsoil " "
354	La Fayette,	2.423	1.475	2.309	1.285	1.340	.215	.463	.115	.176	.062	.214	.053	93.990	Virgin black sand soil.
355	"	1.913	1.250	2.253	1.240	1.190	.215	.353	.065	.126	.050	.178	.053	94.940	Old field " "
356	"	1.363	1.225	1.822	1.640	1.540	.115	.656	.065	.126	.058	.164	.062	93.990	Subsoil " "
357	"	7.970	5.125	6.587	5.590	4.990	4.540	2.839	.140	.182	.084	.657	.191	74.740	Virgin Red River bottom soil.
358	"	8.300	4.955	4.781	5.665	6.115	4.240	2.711	.140	.232	.066	.855	.159	74.990	Old field " "
359	"	7.467	3.475	3.289	4.840	4.715	4.015	2.209	.115	.162	.041	.526	.155	79.415	Subsoil " "
247	Lawrence,	...	...	10.625	21.024		.721	.499	8.636*	.222	.028	.811	.087	57.380	Red clay Hoppe mines.
248	"	2.300	1.325	2.979	2.115	.576	.181	.337	.120	.095	.028	.154	.064	92.820	Virgin Lower Silurian soil.
249	"	2.097	.950	2.019	2.255	1.440	.181	.329	.345	.095	.028	.120	.071	93.320	Old field " "
250	"	1.250	1.050	1.979	5.890†		.196	.245	...	.078	.033	.328	.115	91.270	Subsoil " "
306	Madison,	1.929	2.750	4.653	2.715	1.885	.195	.230	.245	.195	.041	.137	...	89.945	Virgin Brush Co. Subcarb. Barrens.
307	"	2.047	1.925	1.895	1.915	1.725	.170	.248	.220	.174	.033	.140	.015	91.470	Old field " "
308	"	1.623	1.875	2.114	2.325	2.160	.120	.579	.320	.193	.022	.130	.015	91.845	Subsoil " "
251	Marion,	...	...	8.600	24.635†		.820	.766	...	.173	.038	.921	.453	63.615	Red clay.
252	"	2.483	4.265	7.729	5.215	3.465†	.096	.473	...	.230	.067	.301	.152	82.520	Virgin Lower Silurian soil.
253	"	2.225	2.025	4.246	2.665	2.725†	.396	.316	...	.127	.038	.312	.150	88.570	Old field " "
254	"	2.000	1.950	3.534	3.340	2.865†	.296	.317	...	.137	.038	.294	.084	88.960	Subsoil " "
255	"	4.050	1.950	4.308	2.615	2.165†	.346	.304	...	.193	.028	.236	.120	89.920	Virgin Lower Silurian soil.
256	"	3.033	1.825	4.084	2.465	1.990†	.396	.355	...	.176	.033	.188	.134	90.460	Old field " "

257	"	2.000	1.300	2.399	3.340	2.665†	.196	.290	. . .	.117	.025	.249	.141	90.795	Subsoil " "
261	"	5.817	4.650	11.011	5.015	3.810	.646	.815	.295	.147	.084	.693	.583	76.295	Virgin " "
262	"	4.767	3.335	8.964	4.014	2.910	.696	.489	.195	.163	.079	.478	.143	80 645	Old field " "
263	"	3.031	2.825	6.133	3.790	3.350	.346	.526	.295	.162	not est.	.430	.117	83.220	Subsoil " "
297	Monroe,	1.620	1.525	2.193	2.710	1.100	.145	.256	.170	.090	.045	.143	.032	93.973	Virgin Quaternary ? soil.
298	"	1.933	2.315	3.669	1.940	1.660	.320	.266	.145	.156	.058	.101	.013	90.830	Old field soil.
299	"	1.592	1.700	1.959	2.065	1.750	.195	.167	.120	.051	.033	.132	. . .	92.645	Subsoil.
291	Newton,	4.066	4.500	7.722	2.090	2.110	.746	.313	.445	.131	.050	.137	.051	84.945	Virgin Subcarboniferous soil.
292	"	1.950	2.375	3.534	2.090	2.250	.421	.396	.395	.118	.033	.127	.025	90.420	Old field soil.
293	"	1.735	2.075	2.303	3.140	2.460	.196	.347	.470	.084	.042	.170	.054	90 845	Subsoil.
378	Ouachita,	2.224	4.650	8.232	6.085	3.415	.120	.519	.395	.282	.075	.207	.078	80.640	Virgin Tertiary bottom ? soil.
385	Perry,	4.620	2.900	4.505	2.310	2.840	.430	.658	.245	.178	.067	.149	.034	88 915	Virgin Millstone Grit soil.
386	"	1.976	2.175	3.117	2.785	1.635	.220	.353	.220	.160	.058	.106	.058	91.715	Old field " "
387	"	1.090	2.030	2.056	3.985	2.365	.095	.306	.229	.159	.045	.140	.050	90 940	Subsoil " "
388	"	3.987	1.250	1.747	1.435	1.200	.720	.415	.080	.191	.036	.143	.048	94 565	Virgin Millstone Grit ? soil.
389	"	1.718	1.365	1.707	.535	1.310	.370	.472	.120	.181	.050	.186	.056	94.515	Old field soil.
390	"	1.753	2.050	2.050	.610	1.535	.395	.633	.120	.179	.041	.206	.038	93.515	Subsoil.
272	Pike,	5.367	4.100	8.446	2.735	1.495	.645	.562	.295	.163	.092	.155	.035	85 915	Virgin Cretaceous soil.
273	"	1.956	1.250	2.329	1.360	1.240	.170	.395	.120	.062	.050	.101	.021	93.965	Old field " "
274	" *	1.149	1.425	1.775	2.560	2.015	.095	.283	.370	.115	.041	.120	.057	92.765	Subsoil " "
243	Poinsett,	. . .	1.000	2.878	3.265	3.290	.181	.333	.095	.104	.042	.108	.105	90 595	Virgin Quaternary soil.
363	Polk,	5.700	4 225	6.343	5.200	3.515	.240	.419	.220	.247	.062	.193	.023	83.765	Virgin Millstone Grit soil.
364	"	3.700	3.725	3.953	5.485	3.240	.440	.698	.370	.211	.066	.229	.069	85.315	Old field " "
365	"	1.926	2.925	3.322	6.110	3.690	.145	.572	.395	.194	.058	.328	.069	84 990	Subsoil " "
315	Pope,	1.517	2.675	4.212	2.985	1.980	.120	.306	.145	.112	.041	.116	.023	90 395	Virgin soil.
316	"	1.283	2.275	3.581	1 860	3.255	.110	.239	.320	.213	.033	.130	.036	89 670	Old field soil.
317	"	1.150	2.075	2.398	3.085	3.050	.110	.263	.195	.178	.033	.149	.047	90 310	Subsoil.
321	Prairie,	1.230	3.300	4.653	1.725	1.665	.046	.280	.295	.146	.055	.053	.035	90 020	Virgin Millstone Grit prairie soil.
322	"	1.417	1.675	2.491	2.090	1.565	.046	.247	.180	.079	.050	.143	.013	93.080	Old field " "
323	"	.795	1.825	2.138	1.515	2.015	.046	.265	.195	.128	.041	.127	.026	92 330	Subsoil " "
312	Pulaski,	.955	2.275	2.763	1.275	2.190	.070	.219	.145	.063	.027	.058	.045	93.445	Virgin Millstone Grit soil.
313	"	1.100	1.700	2.770	2.390	1.340	.095	.197	.120	.085	.027	.087	.034	92 395	Old field soil.
314	"	.908	1.665	2.354	3.455	2.265	.035	.253	.095	.063	.033	.093	.081	90.910	Subsoil.
397	"	5.667	3.475	5.438	2.835	1.915	.445	.862	.140	.245	.091	.232	.044	87.290	Virgin Millstone Grit soil.
398	"	2.914	3.200	5.191	3.135	1.790	.495	.758	.290	.234	.075	.256	.030	87.415	Old field soil.
399	"	2.654	2.600	3.491	3.820	1.915	.205	1.003	.320	.242	.068	.285	.068	89.240	Subsoil.
400	"	3 128	2.775	4.577	3.860	4 300	.385	.426	.265	.128	.055	.208	.065	85.811	Virgin Granite soil.
401	"	2.600	1.775	3.131	3.285	4 090	.245	.378	.190	.136	.050	.208	.065	88.290	Old field " "
402	"	1.690	1.950	2 524	4.635	4.390	.220	.489	.140	.143	.041	.227	.061	87.340	Subsoil " "
403	"	1.565	5.675	8.326	21.365	7.650	.220	1.266	.140	.189	.045	.347	.384	60.515	Underclay " "
258	Randolph.	5 087	1.725	3.485	2.390	1 610	.371	.630	.230	.160	.042	.183	.045	91.070	Virgin Lower Silurian soil.

* With oxide of zinc.

† And oxide of manganese.

TABLE OF SOILS, &c.—*Continued.*

Number.	County.	Extracted from 1000 grains by Carbonated Water.	Hygroscopic Moisture.	Organic and volatile matters.	Alumina.	Oxide of Iron.	Carbonate of Lime.	Magnesia.	Brown Oxide of Manganese.	Phosphoric Acid.	Sulphuric Acid.	Potash.	Soda.	Sand and Insoluble Silicates.	Remarks.
259	Randolph,	5.166	1.625	3.395	2.515	1.910	0.371	0.475	0.230	0.152	0.033	0.251	0.100	90.535	Old field Lower Silurian soil.
260	"	1.788	1.425	2.105	3.090	2.410	.246	.371	.295	.094	.030	.289	.115	90.230	Subsoil " "
335	Saline,	4.617	3.850	5.460	3.535	2.490	.440	.817	.240	.163	.124	.309	.076	85.940	Virgin Millstone Grit soil.
336	"	3.910	2.700	3.905	2.835	1.915	.415	.708	.240	.280	.058	.203	.042	89.645	Old field " "
337	"	1.762	2.100	2.451	1.185	5.265	.165	.462	.270	.182	.058	.212	.073	89.990	Subsoil " "
345	Scott,	7.233	3.950	7.678	3.385	3.590	1.015	.359	.345	.163	.075	.241	.049	83.540	Virgin bottom soil.
346	"	1.974	1.700	2.950	2.535	2.450	.315	.263	.195	.192	.067	.196	.058	91.240	Old field " "
347	"	2.189	1.650	2.592	3.610	3.340	.165	.513	.220	.149	.050	.220	.079	89.365	Subsoil " "
360	"	3.626	3.225	4.763	4.083	3.065	.190	.316	.145	.261	.050	.193	.037	87.340	Virgin Millstone Grit soil.
361	"	3.767	1.825	4.166	3.885	3.790	.215	.307	.245	.208	.045	.212	.047	86.890	Old field " "
362	"	1.574	2.475	2.873	5.585	4.750	.190	.359	.195	.128	.042	.227	.065	86.215	Subsoil " "
294	Searcy,	2.373	2.000	2.933	1.140	1.320	.593	.184	.195	.078	.042	.164	.007	92.695	Virgin Subcarboniferous soil.
295	"	2.466	2.950	4.662	3.415	2.185	.421	.271	.479	.195	.042	.217	.043	87.947	Old field " "
296	"	1.833	2.425	2.919	3.475	2.410	.196	.364	.470	.151	.033	.150	.057	89.445	Subsoil " "
351	Sebastian,	2.467	2.025	3.675	1.235	4.590	.145	.420	.175	.175	.058	.294	.047	88.990	Virgin prairie soil.
352	"	3.193	2.300	5.168	10.300		.280	.619	.190	.170	.050	.195	.033	83.440	Old field " "
353	"	1.493	2.300	4.247	4.510	6.940	.130	.308	.165	.209	.050	.214	.059	83.240	Subsoil " "
329	Sevier,	6.650	3.875	6.627	3.310	2.090	1.195	.691	.155	.130	.084	.413	.077	84.540	Virgin bottom Cretaceous soil.
330	"	2.923	2.350	3.789	2.785	2.090	.320	.562	.140	.251	.079	.338	.053	89.715	Old field " "
331	"	1.696	7.750	3.631	2.710	2.340	.330	.624	.165	.256	.062	.352	.088	89.040	Subsoil " "
332	"	7.633	4.150	4.616	10.940		4.790	.685	.265	.163	.076	.679	.132	78.290	Red bottom land.
339	"	4.538	7.475	9.213	9.927	3.780	1.940	.490	.251	.262	.077	.432	.125	73.115	Cretaceous soil.
366	"	8.155	9.675	12.005	6.165	4.415	36.410	2.279	.290	.368	.247	.362	.146	37.990	Virgin Cretaceous soil.
367	"	7.592	4.450	7.326	3.490	2.190	66.285	1.169	.240	.147	.170	.214	.085	19.190	Old field " "
368	"	7.794	2.775	4.879	2.740	1.615	79.260	.702	.140	.112	.118	.135	.090	10.915	Subsoil " "
340	Union,	1.456	3.675	6.618	3.735	trace.	.140	.208	trace.	.096	.062	.035	.036	90.715	Camp Creek glady soil.
348	"	2.224	.950	1.893	.285	.965	.020	.301	.140	.052	.027	.029	.095	95.890	Virgin Quaternary soil.
349	"	1.612	.475	1.055	.685	.640	.070	.287	.115	.061	.041	.029	trace.	97.090	Old field " "
350	"	1.318	1.425	1.674	2.935	1.865	.070	.893	.165	.062	.033	.096	.026	92.115	Subsoil " "
279	Van Buren,	3.104	2.550	5.592	3.440	3.635	.196	1.280	.245	.237	.038	.150	.007	86.300	Virgin Millstone Grit soil.
280	"	2.066	1.350	2.787	1.840	3.160	.171	.201	.245	.078	.024	.107	. . .	92.470	Old field soil.
281	"	1.333	1.325	2.407	2.515	1.920	.121	.203	.245	.097	.033	.096	.025	92.120	Subsoil.

276	Washington,	4.642	2.735	5.325	2.015	5.085	0.371	0.457	0.295	0.217	0.050	0.433	0.168	85.820	Virgin Subcarboniferous soil.
277	"	3.302	1.925	4.537	1.715	2.960	.495	.229	.145	.160	.050	.147	.031	89.420	Old field " "
278	"	3.420	2.100	4.571	1.545	3.185	.321	.392	.495	.118	.050	.111	.025	88.795	Subsoil " "
300	White,	1.866	2.800	4.989	2.215	3.035	.220	.418	.220	.143	.055	.121	.018	87.860	Virgin Millstone Grit shales soil.
301	"	1.779	2.075	3.344	2.215	2.335	.130	.340	.195	.269	.055	.145	.025	90.245	Old field soil.
302	"	1.660	2.350	2.714	4.375	2.985	.095	.297	.245	.104	.033	.187	.067	88.845	Subsoil.
391	Yell,	3.228	2.325	4.556	2.165	1.740	.195	.695	.125	.161	.058	.149	.021	90.365	Virgin Millstone Grit soil.
392	"	1.505	1.275	1.890	2.820	1.650	.085	.141	.075	.143	.024	.116	.009	93.390	Old field " "
393	"	1.073	1.600	1.956	3.190	2.940	.045	.339	.115	.208	.033	.162	.072	90.840	Subsoil " "
	STATE.														
a.	Iowa,	. . .	1.815	2.708	2.335	1.790	.315	.796	.120	.159	.050	.198	.020	92.215	Iowa timbered land.
b.	"	. . .	4.625	6.028	4.610	3.515	.665	.855	.120	.181	.110	.311	.097	83.590	Iowa prairie soil.
c.	Minnesota,	. . .	5.500	6.348	5.585	3.765	.565	.944	.095	.237	.074	.299	.094	82.065	Average of best land.
d.	"	. . .	4.250	5.425	4.610	3.765	.690	.890	.180	.230	.093	.310	.053	83.840	Lower Silurian Mag. limestone.
e.	Wisconsin,	. . .	1.315	1.732	.335	1.840	.425	.512	.145	.191	.067	.172	.055	93.905	" " "
f.	"	. . .	3.500	6.580	3.285	2.915	.940	.647	.145	.262	.075	.296	.083	86.240	Average wheat soil.

APPENDIX

TO THE

CHEMICAL REPORT OF THE COMPOSITION OF SOILS, ETC. ETC., OF THE STATE OF ARKANSAS.

BY ROBERT PETER, M.D.,

PROFESSOR OF CHEMISTRY, ETC., IN TRANSYLVANIA UNIVERSITY, ETC. ETC., LEXINGTON, KY.

By considerable exertion the following additional chemical analyses of the soils, &c., collected by the principal geologist, were completed in time for publication in this volume. They are arranged, like the preceding, in the alphabetical order of the counties whence they were obtained.

ARKANSAS COUNTY—*Continued.* (See Nos. 333 and 334.)

No. 406. "*Virgin Soil. Prairie adjoining the Spanish Grant, on Section* 18, *Township* 7 *south, Range* 3 *west, owned by James More. An average of the prairie land of Arkansas County, Arkansas.*"

The dried soil is of a light umber color.

No. 407. "*Same Soil from an old field forty to fifty years in cultivation. Prairie. Spanish Grant. Section* 00, *Township* 7, *Range* 3 *west. Harold Stillwell's farm, Arkansas County.*"

The dried soil is light buff-umber colored, lighter than the preceding.

No. 408. "*Subsoil from the same field. Harold Stillwell's farm, &c.*"

The dried soil is of a dirty-buff-color.

No. 409. "*Virgin Prairie Soil, from the highest of the prairie, on Section* 17, *Township* 7 *south, Range* 3 *west.* (*This is looser and drier than the preceding.*) *Arkansas County, Arkansas.*"

The dried soil is of an umber color.

No. 410. "*Upland Woodland Soil, adjoining the prairie, on the Spanish Grant, Township* 7 *south, Range* 4 *west.* (*Differs from the prairie soil at More's and Farrel's.*)"

The dried soil is of a dark drab-color, lighter and more yellowish than the preceding.

One thousand grains of each of these soils, thoroughly air-dried, were digested for a month, at the ordinary summer temperature, in a close bottle, in water which had been charged with carbonic acid gas. The infusion, after filtration, evaporated and fully dried at 212° F., gave the following dissolved materials, viz.:

	No. 406. Prairie Virgin Soil.	No. 407. Old field Soil.	No. 408. Subsoil.	No. 409. Prairie Virgin Soil.	No. 410. Woodland Virgin Soil.
Organic and Volatile matters, .	0.733	0.633	0.493	1.167	0.800
Alumina, and Oxides of Iron and Manganese, and Phosphates,	1.060	.703	.260	1.776	.500
Carbonate of Lime, ...	.350	.813	.280	.747	.680
Magnesia, ...	.153	.289	.133	.206	.172
Sulphuric Acid, ...	.030	.039	.030	.039	.056
Potash, ...	.048	.161	.126	.067	.084
Soda, ...	.034	.015	.064	.051	.018
Silica, ...	.330	.297	.280	.447	.247
Loss, ...	.295	.017	——	——	——
Total extract, dried at 212° F. (Grains), ...	3 033	2.967	1.666	4.500	2.557

Submitted to chemical analysis, dried at 400° F., the *Composition* of these soils was found to be as follows:

	No. 406. Virgin Prairie Soil.	No. 407. Old field Soil.	No. 408. Subsoil.	No. 409. Virgin Upland Prairie Soil.	No. 410. Virgin Upland Woodland Soil.
Organic and Volatile matters,	4.094	3.509	3.506	4.998	3.814
Alumina, ...	2.535	2.810	4.910	2.660	3.635
Oxide of Iron, ...	2.740	3.415	3.965	2.140	3.015
Carbonate of Lime, . . .	.095	.195	.095	.145	.120
Magnesia, ...	.482	.669	.526	.475	.519
Brown Oxide of Manganese,	.245	.295	.345	.220	.260
Phosphoric Acid, . . .	.212	.211	.118	.163	.173
Sulphuric Acid, ...	.071	.075	.067	.101	.067
Potash, ...	.183	.207	.169	.103	.174
Soda, ...	.050	.104	.044	.072	.053
Sand and Insoluble Silicates,	88.465	87.790	86.460	88.865	87.965
Loss, ...	.828	.720	——	.058	.205
Total, ...	100.000	100.000	100.205	100.000	100.000
Moisture, expelled at 400° F.,	3.690	3.185	3.750	3.950	3.390

No. 411. "*Samples of the so-called 'Buckshot Land,' Section 16, Township 6 south, Range 6 west, Arkansas County, Arkansas. Growth, gum, hackberry, box elder, &c.*"

Dried soil in very tough lumps, of a chocolate, dark-gray color. The

infusion of the soil in carbonated water had a fœtid smell; which was the case with some other soils of this kind.

No. 412. "*Under (or Ironshot) Clay; taken from dug ravines, washed out at Post of Arkansas, Arkansas County, Arkansas. This is the kind of clay that underlies the prairie soil near Post of Arkansas.*"

Dried clay contains moderately friable, rounded lumps of dark-brown Oxide of Iron, and is of a light drab color. Contains no *Protoxide* of Iron.

No. 413. "*Ironshot Gravel in the underclay at the Post of Arkansas, Arkansas County, Arkansas.*"

It contains no *Protoxide* of Iron.

Extracted from 1000 *Grains of Soils Nos.* 411 *and* 412, *by Water charged with Carbonic Acid.*

	No. 411. "Buckshot Soil."	No. 412. Underclay.
Organic and Volatile matters,	1.783	0.933
Alumina, and Oxides of Iron and Manganese, and Phosphates,	.577	.127
Carbonate of Lime,	3.247	.413
Magnesia,	.328	.217
Sulphuric Acid,	.045	.033
Potash,	.121	.055
Soda,	.041	.017
Silica,	.763	.657
Loss,	.095	——
Total Extract, dried at 212° F. (Grains),	7.000	2.452

The composition of these—*soil, underclay,* and *iron gravel*—was found, by chemical analysis, to be as follows:

Composition, dried at 400° *F.*

	No. 411. "Buckshot" Soil.	No. 412. Underclay.	No. 413. Iron Gravel.
Organic and Volatile matters,	7.880	2.470	3.690*
Alumina,	5.410	5.335	16.266†
Oxide of Iron,	5.750	3.515	
Carbonate of Lime,	1.680	.470	trace.
Magnesia,	2.301	.876	1.932
Brown Oxide of Manganese,	.310	.170	——
Phosphoric Acid,	.257	.130	.380
Sulphuric Acid,	.101	.041	.302
Potash,	.642	.212	.417
Soda,	.204	.153	.242
Sand and Insoluble Silicates,	75.740	86.815	76 980
Total,	100.275	100.187	100 209
Moisture, expelled at 400° F.,	8.000	4.250	

* Principally Water. † And Oxide of Manganese.

The "Buckshot" soil is very rich in all the elements of vegetable nutrition, a large proportion of which is in a soluble condition. Its great toughness appears to be due partly to the condition of its *organic* ingredients, partly to its considerable proportions of Carbonate of Lime and Magnesia, and partly to the fine state of division of its *silicious* material. It must be very productive if well drained, and not found to be too close and adhesive in cultivation. The proportion of its *Potash*, particularly, is unusually large.

"*Cotton and Cotton Seed, grown on the Arkansas River Bottom, at Farrelly's and More's, near the Post of Arkansas. Collected for the analyses of the ash of each separately; to see what is carried off by each crop. Crop from* 1000 *to* 2000 *pounds to the acre in the seed, which loses from two-thirds to three-fourths of its weight by cleaning* (*ginning.*)"

The results of the analyses of the ashes of the cotton lint and cotton seed are as follows:

In 100 parts of each, dried at the ordinary temperature and carefully burnt to ashes, were found the following proportions of mineral materials, viz.:

	In 100 parts of Cotton Lint.	In 100 parts of Cotton Seed.
Potash,	0.388	0.620
Soda,	.028	.310
Lime,	.138	.159
Magnesia,	.185	.698
Phosphoric Acid,	.125	1.600
Sulphuric Acid,	.096	.092
Chlorine,	.024	.060
Silica and Sand,	.457	.120
Carbonic Acid and Loss,	.254	.111
Total Ashes,	1.695	3.770 per cent.

A considerable quantity of adhering fine *Sand*, especially in the cotton, increases the apparent proportion of the *Silica, &c.*, the precaution not having been taken to separate this *sand* from the *soluble Silica* in the analysis.

It will be seen from these ash analyses, that the *lint* of the cotton plant removes from the soil more of *Potash* than of any other essential ingredient of the soil, whilst the *seed*, which require a much larger proportion of all the mineral elements than the lint, takes up the *Phosphoric Acid* in greatest quantity.

The amount of the essential ingredients of the soil which is alienated from it in a crop of cotton, say of 1500 pounds, in the seed, may be thus calculated; taking as data the preceding analyses, and the proportion of lint to the seed as 400 pounds: 1100 pounds; disregarding the stalks, &c.

Mineral ingredients of the Soil removed from it in a Cotton Crop.

	In 400 pounds of Cotton Lint.	In 1100 pounds of Cotton Seed.
Potash,	1.552 pounds.	6.820 pounds.
Soda,	.112 "	3.400 "
Lime,	.582 "	1.790 "
Magnesia,	.740 "	7.678 "
Phosphoric Acid,	1.000 "	17.600 "
Sulphuric Acid,	.384 "	1.010 "
Chlorine,	.096 "	.660 "
Total,	4.466 pounds.	38.958 pounds.

It appears from these data, that the *seed* of the cotton robs the soil of about eight times as much of its *essential* nutritive ingredients as the lint itself; and, particularly, takes away from it nearly eighteen times as much of that important material, *Phosphoric Acid.* Hence, doubtless, is it that cotton seed have been found by experience to be such a good manure for the cotton field; and it is obviously the interest of every planter carefully to preserve them for this use. The previous expression of the oil, which will undoubtedly be profitable to the cotton planter, will not detract from the value of the seed as manure.

No. 414. "*Virgin Soil; Arkansas River Bottom cotton soil. Col. Farrelly's land; Spanish Grant, Township* 7, *Range* 4 *west, Arkansas County, Arkansas.*"

A sandy soil, containing minute specks of mica, of a warm brownish-gray color.

No. 415. "*Soil from a cotton field, Arkansas River bottom, on Col. Farrelly's plantation, fifteen years in cultivation and twelve years in cotton.* (*This sample was taken from a part of the field where the cotton was most liable to rust, especially in* 1857,—*to ascertain whether it was caused by exhaustion of some of the ingredients of the soil requisite for the perfect growth of the plant.*")

Dried soil darker than the preceding, of light powdered chocolate color. Sandy, containing small specks of mica.

No. 416. "*Subsoil of the field fifteen years in cultivation. Col. Farrelly's plantation, Arkansas River Bottom, Arkansas County, Arkansas.*"

Dried soil a little lighter colored than the preceding; not so sandy; does not appear to contain mica.

Extracted from 1000 *Grains of each of these Soils, by Digestion in Water charged with Carbonic Acid Gas.*

	No. 414. Virgin Soil.	No. 415. Old field Soil.	No. 416. Subsoil.
Organic and Volatile matters,	0.750	0.600	1.066
Alumina, and Oxides of Iron and Manganese, and Phosphates,	.703	.503	.830
Carbonate of Lime,	1.117	1.420	2.747

	No. 414. Virgin Soil.	No. 415. Old field Soil.	No. 416. Subsoil.
Magnesia,	.258	.367	.358
Sulphuric Acid,	.022	.022	.027
Potash,	.085	.064	.048
Soda,	.046	.060	.057
Silica,	.430	.380	.530
Total extract, dried at 212° F. (Grains),	3.414	3.416	5.663

Chemical Composition, dried at 400° *F.*

	No. 414. Virgin Soil.	No. 415. Old field Soil.	No. 416. Subsoil.
Organic and Volatile matters,	1.803	2.444	5.091
Alumina,	2.185	2.260	6.085
Oxide of Iron,	1.740	1.765	4.640
Carbonate of Lime,	.380	.520	.970
Magnesia,	.737	.664	1.555
Brown Oxide of Manganese,	.170	.270	.245
Phosphoric Acid,	.127	.143	.221
Sulphuric Acid,	.050	.046	.084
Potash,	.201	.295	.714
Soda,	.100	.078	.080
Sand and Insoluble Silicates,	93.415	92.215	81.240
Total,	100.908	100.700	100.925
Moisture, expelled at 400° F.,	1.550	1.800	4.925

The soil of the old field is actually richer than the virgin surface soil, but the reason is obvious in the greatly richer subsoil, some of which has doubtless been brought up and mixed with the surface soil of the cultivated field by the action of the plough. The surface soil of this locality is sandy and only second-rate in fertility, but the subsoil is very rich in *Potash*, &c. &c., and by deep subsoiling the land would be greatly improved in productiveness. Whether the rust in the cotton is favored by this condition of the surface soil, can readily be ascertained by experiments in subsoiling. It may be stated that in most cases where animals or vegetables are imperfectly nourished, they are more liable to be afflicted with parasitic growths than when an abundant supply of food produces a vigorous development.

CRAIGHEAD COUNTY.

No. 417. "*Virgin Soil, from Ira Folk's plantation, Mamelle Prairie, Section ?, Township* 13, *Range* 6, *edge of the sunk land, Craighead County, Arkansas.* (*Derived from the Quaternary.*)".

Dried soil of a light umber color. It contains small, clear, rounded grains of sand.

No. 418. "*Same Soil from an old field twenty-three to twenty-four years in cultivation. Ira Folk's plantation, &c. &c.*"

The dried soil resembles the preceding, but is a slight shade darker in color.

No. 419. "*St. Francis Bottom Soil. Growth, gum, elm, white oak, black hickory, and hackberry. Land near the Little Bug, Craighead County, Arkansas.*"

Dried soil of a light mouse-color; in very tenacious lumps, containing vegetable twigs, remains of leaves, &c.

Extracted from 1000 *Grains of each of these three Soils, by Digestion in Water charged with Carbonic Acid.*

	No. 417. Virgin Soil.	No. 418. Old field Soil.	No. 419. St. Francis Soil.
Organic and Volatile matters,	0.950	0.717	1.933
Alumina, and Oxides of Iron and Manganese, and Phosphates,	1.160	.547	.847
Carbonate of Lime,	1.280	1.620	1.497
Magnesia,	.217	.217	.291
Sulphuric Acid,	.027	.022	.022
Potash,	.058	.148	.090
Soda,	.057	.052	.048
Silica,	.497	.330	.397
Loss,	037	.247	.289
Total Extract, dried at 212° F. (Grains),	4.283	3.900	5.417

On submitting them to complete chemical analysis, the *Composition* of these soils, dried at 400° F., was found to be as follows:

	No. 417. Virgin Soil.	No. 418. Old field Soil.	No. 419. St. Francis Soil.
Organic and Volatile matters,	3.778	4.833	12.728
Alumina,	2.110	2.585	7.485
Oxide of Iron,	2.370	1.915	4.640
Carbonate of Lime,	.345	.470	.720
Magnesia,	.504	.720	.745
Brown Oxide of Manganese,	.270	.245	.245
Phosphoric Acid,	.151	.215	.259
Sulphuric Acid,	.062	.101	.110
Potash,	.256	.233	.454
Soda,	.316	.095	.142
Sand and Insoluble Silicates,	89.465	90.115	72.915
Loss,	.373	——	——
Total,	100.000	101.527	100.443
Moisture, expelled at 400° F.,	2.725	2.200	8.750

The St. Thomas bottom soil is remarkable for the large proportion of *Organic matters* which it contains, which aids much in causing its great adhesiveness. It may be considered quite a fertile soil if properly drained.

The soil of the old field does not exhibit any diminution of its essential ingredients, except in the alkalies.

CRITTENDEN COUNTY.

No. 420. "*St. Francis and Mississippi Bottom Land, outside of Col. Austell's field. Growth, large oaks. Crittenden County, Arkansas.*"

Dried soil of a light mouse-color, in quite tenacious lumps.

No. 421. "*Cane Land Soil from an old field twenty years in cultivation. Cook's plantation, Section* 21 *or* 24, *Township* 7 *south, Range* 4 *west. St. Francis and Mississippi River bottom. Crittenden County. Growth, hickory, sassafras, hackberry. Collected at the foot of an aboriginal mound.*"

Dried soil of a dark chocolate, brownish-gray color.

No. 422. "*Gum Soil; St. Francis River bottom; Col. Austell's plantation. Crittenden County, Arkansas.*"

Dried soil of a light mouse-color; in very tenacious lumps.

No. 423. "*Genuine Buckshot Land on Esquire Hinton's place, Section* 15, *Township* 7 *south, Range* 4 *west. Bottom land. Crittenden County, Arkansas.*"

Dried soil mouse-colored; in tenacious lumps.

Extracted from 1000 *Grains of each of these Soils, by Digestion for a Month in Water charged with Carbonic Acid Gas.*

	No. 420. St. Fr. and Miss. Bottom Land.	No. 421. Cane Land (Bottom.)	No. 422. Gum Soil, Bottom Land.	No. 423. Buckshot Land (Bottom.)
Organic and Volatile matters,	1.333	0.300	0.650	1.973
Alumina, and Oxides of Iron and Manganese, and Phosphates,	.660	.327	.443	1.460
Carbonate of Lime,	2.147	.803	1.577	3.910
Magnesia,	.722	.300	.356	.622
Sulphuric Acid,	.022	.016	.030	.050
Potash,	.071	.050	.044	.119
Soda,	.033	.046	.027	.042
Silica,	.380	.247	.330	.513
Loss,	——	——	——	.268
Total Extract, dried at 212° F.,	5.368	2.089	3.457	8.957

The *Chemical Composition of these soils, dried at* 400° *F.*, was found to be as follows:

	No. 420. Oak Land. Bottom Soil.	No. 421. Cane Land. Bottom Soil.	No. 422. Gum Soil. Bottom Land.	No. 423. Buckshot Land Bottom Soil.
Organic and Volatile matters,	9.319	2.885	6 599	9.527
Alumina,	10.485	4.370	9.685	10.185
Oxide of Iron,	6.390	1.715	6.240	6.765
Carbonate of Lime,	1.145	.520	1.170	1.610
Magnesia,	1.070	1.044	1.155	1.837
Brown Oxide of Manganese,	.295	.245	.320	.170
Phosphoric Acid,	.347	.261	.294	.367
Sulphuric Acid,	.101	.041	.067	.101
Potash,	.711	.393	.758	.854
Soda,	.138	.068	.232	.054
Sand and Insoluble Silicates,	71.095	87.595	73.645	70.370
Loss,	——	.863	——	——
Total,	101.096	100.000	100.165	101.810
Moisture, expelled at 400° F.,	8.950	3.200	8.475	9.475

These bottom lands, if sufficiently drained, and not too adhesive for thorough cultivation, must be exceedingly productive. They generally contain an unusually large proportion of *Potash*, much *Lime*, *Magnesia*, *Phosphoric and Sulphuric Acids*, and *Organic matters*. No. 421 is less rich than the three others in these essential materials, and contains more sand and less alumina and oxide of iron. The other three have so much of these latter substances as to make them tenacious *loamy*, or even *clay* soils.

JEFFERSON COUNTY.

No. 424. "*Soil from a new field on the new plantation of J. B. Hall, north half Section* 19, *Township* 5 *south*, *Range* 7 *west. Jefferson County, Arkansas.*"

Dried soil mouse-colored, with a tint of umber.

No. 425. "*Subsoil from the trench at the mill-seat adjoining J. B. Hall's plantation, Section* 19, *Township* 5 *south, Range* 7 *west. Jefferson County, Arkansas.*"

Dried soil of a light brickdust color.

No. 426. "(*Polished buckshot*), *or stiff red or chocolate-colored land. Dr. Williams's plantation, Section* 9, *Township* 6 *south, Range* 7 *west. Jefferson County, Arkansas.*" (*Cuts like cheese or soap.*)

Dried soil is of a powdered chocolate color; in very tenacious lumps.

No. 427. "*Subsoil of a stiff red or chocolate-colored soil, three years in cultivation. Dr. Williams's plantation, &c.*"

Dried soil like preceding.

No. 428. "*Black elm, ash, oak, and hickory land. Section* 20, *Township* 5, *Range* 7. *John M. Bass's land. Jefferson County, Arkansas.*"

The dried soil is of a powdered chocolate color; having tenacious lumps.

No. 429. "*Cotton Soil that polishes with the plough; J. M. Bass's cotton*

field, Section 30, Township 5 south, Range 7 west, six inches below the surface. Jefferson County, Arkansas."

Dried soil like the preceding.

Extracted from 1000 *Grains of each of these air-dried Soils, by Digestion for a Month in Water charged with Carbonic Acid Gas.*

	No. 424. New field.	No. 425. Subsoil.	No. 426. Red Buckshot Soil.	No. 427. Subsoil.	No. 428. Elm, Oak, and Hickory land.	No. 429. Polished Cotton Soil.
Organic and Volatile matters,	2.283	0.517	0.607	0.450	0.983	0.867
Alumina, Oxides of Iron and Manganese, and Phosphates,	.727	.310	.377	.360	1.060	.310
Carbonate of Lime,	5.177	.460	2.160	1.960	3.293	1.103
Magnesia,	.667	.283	.367	.372	.040	.361
Sulphuric Acid,	.170	.019	.022	.056	.039	.030
Potash,	.804	.038	.096	.051	.067	.051
Soda,	.156	.042	.068	.063	.063	.113
Silex,	.647	.447	.463	.497	.547	.263
Loss,	.419	——	——	——	——	——
Total Extract, dried at 212° F. (Grains),	11.050	2.116	4.160	3.809	6.092	3.098

Chemical Composition, dried at 400° *F.*

	No. 424. New field.	No. 425. Subsoil.	No. 426. Red Buckshot Soil.	No. 427. Subsoil.	No. 428. Elm, Oak, and Hickory land.	No. 429. Polished Cotton Soil.
Organic and Volatile matters,	6.568	2.384	7.379	5.511	7.879	6.750
Alumina,	1.410	6.060	9.995	10.335	11.360	6.560
Oxide of Iron,	1.940	3.490	5.965	7.000	6.815	4.615
Carbonate of Lime,	2.245	.295	1.370	1.345	.995	1.095
Magnesia,	.929	1.100	2.871	2.513	2.577	1.292
Brown Oxide of Manganese,	.295	.095	.145	.345	.195	1.170
Phosphoric Acid,	.301	.193	.351	.457	.328	.258
Sulphuric Acid,	.110	.041	.050	.067	.135	not estimated.
Potash,	.502	.441	.898	1.013	.941	.710
Soda,	.111	.107	.149	.175	.125	.147
Sand and Insoluble Silicates,	85.545	85.745	71.980	71.165	70.240	78.990
Loss,	.044	.049	——	.074	——	——
Total,	100.000	100.000	101.153	100.000	101.590	101.587
Moisture, expelled at 400° F.,	3.325	3.550	7.850	8.350	8.435	5.200

These, like the preceding bottom soils, are extraordinarily rich in the elements of vegetable food. In no soils yet examined by the author has he found so large a proportion of *Potash*, which, in soil No. 427, *forms more than one per cent of its weight.*

MONROE COUNTY—(*Continued.*)

No. 430. "*Virgin Soil; Mr. S. Hall's land, Section 11, Township 2 north, Range 1 east. Growth, white oak, hickory, dogwood, red and post oak, some black and sweet gum, and sassafras. Soil mostly derived from Quaternary. Monroe County, Arkansas.*"

Dried soil of a gray-buff color.

No. 431. "*Same Soil; Mr. S. Hall's land, Section* 11, *Township* 2 *north, Range* 1 *east. Twelve years in cultivation, &c. Monroe County, Arkansas.*"

Dried soil of a dirty gray-buff color.

No. 432. "*Subsoil of the same land, &c.*"

Dried soil gray-buff, lighter than the preceding.

No. 433. "*Little Prairie Soil, near Moreau post-office. Growth, coarse grass, wild indigo and sassafras shrubs in places. Now being ditched with a view to cultivation. Derived mostly from Quaternary. Monroe County.*"

Dried soil of an umber-gray color, darker than the preceding.

No. 434. "*Subsoil, Little Prairie, near Moreau post-office; never in cultivation. Monroe County, Arkansas.*"

Dried soil of an ash-gray color.

No. 435. "*Red Clay from Little Prairie, near Moreau post-office; about two and a half feet below the surface.*"

The dried clay is of a brownish-cinnamon color.

Extracted from 1000 *Grains of each of these Soils (thoroughly air-dried), by Digestion for a Month at the Summer Temperature in Water charged with Carbonic Acid.*

	No. 430. Virgin Soil.	No. 431. Cultivated Soil.	No. 432. Subsoil.	No. 433. Little Prairie Soil.	No. 434. Subsoil.	No. 435. Red Clay.
Organic and Volatile matters,	0.767	0.350	0.214	0.473	0.377	0.517
Alumina, Oxides of Iron and Manganese, and Phosphates,	.247	.230	.090	.313	.197	.197
Carbonate of Lime,	.696	1.957	.347	.380	.273	.147
Magnesia,	.178	.139	.317	.144	.150	.527
Sulphuric Acid,	.031	.027	.033	.017	.033	.011
Potash,	.058	.116	.045	.029	.035	.035
Soda,	.027	.051	.033	.061	.125	.228
Silica,	.210	.293	.260	.527	.443	.377
Loss,	.403	——	——	——	——	——
Total Extract, dried at 212° F.,	2.617	3.173	1.312	1.944	1.633	2.039

Chemical Composition of these Soils, dried at 400° *F.*

	No. 430. Virgin Soil.	No. 431. Cultivated Soil.	No. 432. Subsoil.	No. 433. Little Prairie Soil.	No. 434. Subsoil.	No. 435. Red Clay.
Organic and Volatile matters,	3.463	3.397	2.546	3.748	2.374	4.296
Alumina,	3.037	3.735	4.485	3.435	4.885	9.820
Oxide of Iron,	1.965	2.415	2.940	2.465	2.790	5.315
Carbonate of Lime,	.220	.420	.195	.195	trace.	.145
Magnesia,	.831	.915	.382	1.263	.504	2.335
Brown Oxide of Manganese,	.245	.345	.195	.245	.195	.170
Phosphoric Acid,	.221	.146	.299	.165	.129	.251
Sulphuric Acid,	lost.	lost.	.154	.075	.060	.060
Potash,	.386	.401	.227	.217	.290	.338
Soda,	.034	.034	.075	.069	.075	.153
Sand and Insoluble Silicates,	89.415	88.740	88.165	88.490	88.395	76.495
Loss,	.183	——	.337	——	.303	.622
Total,	100.000	100.548	100.000	100.367	100.000	100.000
Moisture, expelled at 400° F.,	2.550	2.435	2.800	3.300	3.125	5.750

Although good soils, these are by no means as rich as those from the bottom lands just described.

PHILLIPS COUNTY.

No. 436. "*Virgin Soil, from what is called 'Buckshot land,' Low Bottom, Section 6, Township 3 south, Range 5 east; E. E. Cooper's plantation. Principal growth, cottonwood, sycamore, ash, elm, and mulberry. Phillips County, Arkansas.*"

Dried soil mouse-colored. In very tenacious lumps.

No. 437. "*E. E. Cooper's Black (Buckshot) Soil, Section 6, Township 3 south, Range 5 east, eight years in cultivation; said to be the most productive in the county. Phillips County, Arkansas.*"

Dried soil of a dark ash gray color, lighter than preceding. In very tenacious lumps.

No. 438. "*Subsoil from the same field, eight years in cultivation, &c. &c.*"

Dried soil of an ash-gray color, lighter than the preceding.

No. 439. "*Virgin Soil, Section 6, Township 3 south, Range 5 east. Sandy loam; high (sugar-tree) ridge, on Long Lake; E. E. Cooper's land. Primitive growth, sweet gum, red elm, sugar-tree, hackberry, box elder, white elm, large red oak, pawpaw, black walnut, sassafras, muscadine and other grape vines. Derived from the Quaternary. Phillips County, Arkansas.*"

Dried soil of a light umber color.

No. 440. "*Soil from the same land (high sugar-tree ridge), seventeen years in cultivation; E. E. Cooper's land, &c. &c.*"

Dried soil of a dark umber-gray color, with a slight yellowish tint, lighter than the preceding.

No. 441. "*Subsoil of the same old field, &c. &c.*"

The dried soil is lighter colored and more yellowish than the preceding.

Extracted from 1000 Grains of each of these air-dried Soils, by Digestion in Water charged with Carbonic Acid.

	No. 436. Bottom Virgin Soil.	No. 437. Bottom Cultiv'd Soil.	No. 438. Bottom Subsoil.	No. 439. High Ridge Virgin Soil.	No. 440. High Ridge Cultiv'd Soil.	No. 441. High Ridge Subsoil.
Organic and Volatile matters,	1.300	0.523	0.367	1.540	0.350	0.217
Alumina, and Oxides of Iron and Manganese, and Phosphates,	.813	.198	.098	1.248	.098	.080
Carbonate of Lime,	3.813	1.697	1.463	2.403	1.080	.630
Magnesia,	.543	.161	.261	.328	.239	.200
Sulphuric Acid,	.040	.057	.047	.033	.024	.025
Potash,	.093	.129	.087	.109	.100	.042
Soda,	.063	.016	.072	.041	.031	.027
Silica,	.643	.164	.314	.681	.348	.259
Loss,	.475	——	——	.040	——	.003
Total Extract, dried at 212° F. (Grains),	7.783	2.945	2.709	6.423	2.270	1.483

Composition of these Soils, dried at 400° F.

	No. 436. Bottom Virgin Soil.	No. 437. Bottom Cultiv'd Soil.	No. 438. Bottom Subsoil.	No. 439. High Ridge Virgin Soil.	No. 440. High Ridge Cultiv'd Soil.	No. 441. High Ridge Subsoil.
Organic and Volatile matters,	14.390	7.588	5.578	5.555	3.231	1.689
Alumina,	6.802	10.360	9.600	3.870	2.460	3.385
Oxide of Iron,	5.485	6.340	6.840	2.965	3.115	2.710
Carbonate of Lime,	2.378	2.620	1.620	1.055	.975	.845
Magnesia,	1.721	1.941	1.703	2.057	.989	.746
Brown Oxide of Manganese,	.200	.220	.220	.220	.270	.220
Phosphoric Acid,	.303	.491	.314	.297	.253	.259
Sulphuric Acid,	.165	.110	.084	.075	.060	.050
Potash,	.493	.852	.777	.347	.391	.304
Soda,	.108	.279	.244	.108	.175	.156
Sand and Insoluble Silicates,	67.542	70.320	73.220	84.840	88.864	90.400
Loss,	.413	——	——	——	——	——
Total,	100.000	101.121	100.200	101.389	100.783	100 764
Moisture, expelled at 400° F.,	11.225	9.400	9.475	4.150	3.300	2.325

The analyses show that the bottom soils not only contain more *Alumina and Oxide of Iron* and less *Sand and Silicates* than the ridge land soil, but that they are much richer in *Organic matters*, in *Carbonate of Lime*, *Phosphoric and Sulphuric Acids*, and *Potash*. To the great abundance of these essential materials present in soil No. 437 must we attribute its great productiveness.

No. 442. "*Virgin Soil; J. W. Rice's land, Section* 5, *Township* 2 *south, Range* 4 *east. Growth, beech, sweet and red gum, poplar, red oak, Spanish oak, white oak, elm, ash, mulberry, black walnut, sassafras, red bud, box elder, honey locust, and some black gum. Called table land. It is at the foot of Crowley's Ridge, and derived from the Quaternary. Phillips County, Arkansas.*"

The dried soil is of a dark ash-gray color.

No. 443. "*Same Soil; J. W. Rice's plantation; thirty years in cultivation, Section* 5, *Township* 2 *south, Range* 4 *east. Phillips County, Arkansas, &c.*"

The dried soil is of a dirty gray-buff color.

No. 444. "*Subsoil of the same old field, &c. &c.*"

The dried soil is of a brownish-buff color.

The surface soil after calcination became of a light-gray color, showing paucity of Oxide of Iron. The soil of the old field burnt of a cinnamon color; and the subsoil, containing much more of this oxide, became of a brick-red, after its organic matters had been removed by ignition.

Extracted from 1000 Grains of each of these Soils, thoroughly air-dried, by Digestion for a Month in Water charged with Carbonic Acid.

	No. 442. Virgin Soil.	No. 443. Old field Soil.	No. 444. Subsoil.
Organic and Volatile matters,	0.867	0.273	0.183
Alumina, and Oxides of Iron and Manganese, and Phosphates,	.148	.098	.048
Carbonate of Lime,	3.247	.680	.663
Magnesia,	.300	.267	.112
Sulphuric Acid,	.027	.022	.032
Potash,	.093	.063	.038
Soda,	——	.035	.021
Silica,	.298	.198	.198
Total Extract, dried at 212° F. (Grains),	4.980	1.636	1.295

Composition of these Soils, dried at 400° F.

	No. 442. Virgin Soil.	No. 443. Old field Soil.	No. 444. Subsoil.
Organic and Volatile matters,	5.300	1.929	3.462
Alumina,	2.970	2.175	8.110
Oxide of Iron,	1.640	2.190	5.465
Carbonate of Lime,	.595	.270	.520
Magnesia,	.359	.393	.783
Brown Oxide of Manganese,	.395	.220	.195
Phosphoric Acid,	.444	.192	.332
Sulphuric Acid,	.079	.060	.040
Potash,	.220	.217	.432
Soda,	.004	.064	.141
Sand and Insoluble Silicates,	88.450	92.290	81.900
Total,	100.456	100.000	100.380
Moisture, expelled at 400° F.,	3.425	1.550	4.700

The influence of the thirty years' cultivation of the soil of the old field is shown in its diminished proportions of soluble *Extract*, of the Organic matters, Carbonate of Lime, *Phosphoric and Sulphuric Acids* and *Potash*, and in its increased proportion of *Sand and Insoluble Silicates*. The *subsoil* is so much richer in *Phosphoric Acid* and Potash than the surface soil of the old field, that subsoil ploughing must be advantageous.

No. 445. "*Virgin Soil from Wm. H. Calvert's plantation, Section* 18, *Township* 2 *south, Range* 5 *east. Hill land, southern termination of Crowley's Ridge. Quaternary. Derived from the clay and sand above the gravel bed. Principal growth, large poplars, beech, black walnut, white walnut, sweet gum, red, black, white, Spanish and post oaks, and sugar tree. Phillips County, Arkansas.*"

The dried soil is of a dark drab color.

No. 446. "*Same Soil from Wm. H. Calvert's plantation, thirty-five years in cultivation, &c.*"

The dried soil is of a dark drab color.

No. 447. "*Subsoil of the same old field, &c. &c.*"

The dried soil is of a buff-gray or drab color; lighter than the preceding.

No. 448. "*Soil from General G. Pillow's plantation, near Helena, twelve years in cultivation. Sandy loam. Section ?, Township 2 south, Range 5 east. Phillips County, Arkansas.*"

The dried soil is of a dark drab color. It contains much sand.

Extracted from 1000 *Grains of each of these Soils, by Digestion for a Month in Water charged with Carbonic Acid.*

	No. 445. Virgin Soil.	No. 446. Old field Soil.	No. 447. Subsoil.	No. 448. Gen. Pillow's.
Organic and Volatile matters,	0.717	0.443	0.233	0.500
Alumina, and Oxides of Iron and Manganese, and Phosphates,	.247	.163	.063	.197
Carbonate of Lime,	.964	1 263	.647	2.220
Magnesia,	.100	.080	.250	.167
Sulphuric Acid,	.013	.028	.017	.033
Potash,	.168	.071	.006	.015
Soda,	Not estimated.	.029	.017	.023
Silica,	.131	.181	.214	.198
Loss,	.577	.042	——	.580
Total Extract, dried at 212° F. (Grs.),	2.917	2.300	1.447	3.933

Chemical Composition of these Soils, dried at 400° *F.*

	No. 445. Virgin Soil.	No. 446. Old field Soil.	No. 447. Subsoil.	No. 448. Gen. Pillow's.
Organic and Volatile matters,	3.148	2.931	1.719	1.835
Alumina,	2.735	2.860	3.360	3.305
Oxide of Iron,	1.950	1.750	2.290	2.615
Carbonate of Lime,	.330	.420	.445	1.020
Magnesia,	.618	.664	.357	.828
Brown Oxide of Manganese,	.425	.725	.290	.395
Phosphoric Acid,	.242	.194	.193	.209
Sulphuric Acid,	.050	.041	.080	.024
Potash,	.246	.164	.188	.270
Soda,	.117	.048	.012	.101
Sand and Insoluble Silicates,	90.790	90.290	91.790	90.615
Total,	100 651	100.087	100.724	101.220
Moisture, expelled at 400° F.,	2.175	2.150	2.000	1.900

The soil of the old field shows signs of deterioration from its thirty-five years of cultivation, in the diminution of its *Soluble Extract*, its *Organic and Volatile matters, Phosphoric and Sulphuric Acids, Potash, and Soda*, as compared with the virgin soil. The subsoil is not generally richer in essential

materials than the surface soil. Gen. Pillow's soil is richer and more productive than its sandy appearance might lead one to suppose. Like all sandy soils, it gives up its essential materials readily to water charged with carbonic acid, and hence, other things being equal, may be more quickly exhausted by continued cultivation than more heavy soils.

ST. FRANCIS COUNTY.

No. 449. "*Virgin Soil; Gov. Mark Izzard's land. Growth, sweet gum, black hickory, poplar, walnut, dogwood, red bud, black ash, elm, muscadine, and other grape vines. Quaternary. St. Francis County, Arkansas.*"

The dried soil is light mouse-colored.

No. 450. "*Same Soil twenty to thirty years in cultivation. Gov. Izzard's plantation. Old Mt. Vernon, &c. &c.*"

Dried soil of a dark drab color, lighter than preceding.

No. 451. "*Subsoil of the same, &c. &c.*"

Dried soil of a dark drab color.

Extracted from 1000 *Grains of each of these Soils (thoroughly air-dried), by Digestion for a Month in Water charged with Carbonic Acid.*

	No. 449. Virgin Soil.	No. 450. Old field Soil.	No. 451. Subsoil.
Organic and Volatile matters,	1.133	0.567	0.250
Alumina, and Oxides of Iron and Manganese, and Phosphates,	.680	.140	.097
Carbonate of Lime,	4.430	1.493	.850
Magnesia,	.111	.073	.450
Sulphuric Acid,	.032	.006	.022
Potash,	.179	.077	.097
Soda,	.062	.063	.047
Silica,	.298	.281	.248
Loss,	——	.267	——
Total extract, dried at 400° F. (Grains),	6.925	2.967	2.061

Chemical Composition of these Soils, dried at 400° *F.*

	No. 449. Virgin Soil.	No. 450. Old field Soil.	No. 351. Subsoil.
Organic and Volatile matters,	8.555	3.619	1.893
Alumina,	3.835	3.035	3.710
Oxide of Iron,	2.125	2.340	2.515
Carbonate of Lime,	1.345	.470	.770
Magnesia,	.494	.532	.566
Brown Oxide of Manganese,	.370	.390	.415
Phosphoric Acid,	.555	.210	.144
Sulphuric Acid,	.084	.067	.033

	No. 449. Virgin Soil.	No. 450. Old field Soil.	No. 451. Subsoil.
Potash,	.246	.261	.285
Soda,	.032	.046	.066
Sand and Insoluble Silicates,	83.390	89.790	90.240
Total,	101.031	100.760	100.637
Moisture, expelled at 400° F.,	5.325	2.600	2.200

The influence of the twenty to thirty years' cultivation on the soil of the old field, is shown in its smaller proportions of *Hygroscopic moisture, Soluble Extract, Organic and Volatile matters, Lime, and Phosphoric and Sulphuric Acids,* than are contained in the virgin soil. The proportions of *Potash, Magnesia, and Oxide of Manganese* seem to have been maintained by the admixture or influence of the subsoil.

TABLE OF SOILS, SUBSOILS, CLAYS, &c.

Number in Report.	County.	Extracted from 1000 grains by Carb. Acid Water	Hygroscopic Moisture.	Organic and Volatile Matters.	Alumina.	Oxide of Iron.	Carbonate of Lime.	Magnesia.	Brown Oxide of Manganese.	Phosphoric Acid.	Sulphuric Acid.	Potash.	Soda.	Sand and Insoluble Silicates.	Remarks.
406	Arkansas, (continued.)	3.033	3.690	4.094	2.535	2.740	0 095	0.482	0.245	0.212	0.071	0.183	0.050	88.465	Virgin prairie soil.
407	"	2.967	3.165	3.509	2.810	3.415	.195	.669	.295	.211	.075	.207	.104	87.790	Old field " "
408	"	1.666	3.750	3 506	4 910	3.965	.095	.526	.345	.118	.067	.169	.044	86.460	Subsoil.
409	"	4.500	3.950	4 988	2.660	2.140	.145	.475	.220	.163	.101	.103	.072	88.865	Virgin upland prairie.
410	"	2.577	3.390	3.814	3.635	3.015	.120	.519	.260	.173	.067	.174	053	87.965	Virgin upland woodland.
411	"	7.000	8.000	7.880	5.410	5.750	1.680	2.301	.310	.257	.101	.642	.204	75.740	"Buckshot" soil.
412	"	2.452	4.25	2 470	5.335	3.515	.470	.876	.170	.130	.041	.212	.153	86.815	Underclay.
413	"	. . .	. . .	3.690	16,266		trace.	1.932	. . .	.380	.302	.417	.242	76.980	Iron gravel.
414	"	3 411	1.550	1 803	2 185	1.740	.380	.737	.170	.127	.050	.201	.100	93.415	Virgin soil.
415	"	3.416	1.800	2.444	2.260	1.765	.520	.664	.270	.143	.046	.295	.078	92.215	Old field soil.
416	"	5.663	4.925	5.091	6.085	4.640	.970	1.555	.245	.221	.084	.714	.080	81.240	Subsoil.
417	Craighead,	4.283	2 725	3 778	2.110	2.370	.315	.504	.270	.154	.062	.256	.316	89.465	Virgin prairie soil.
418	"	3.900	2.200	4.833	2 585	1.915	.470	.720	.245	.215	.101	.233	.095	90.115	Old field prairie soil.
419	"	5.417	8.750	12.728	7 485	4.640	.720	.745	.245	.259	.110	.454	.142	72.915	St. Francis bottom soil.
420	Crittenden,	5.368	8.950	9.319	10.485	6.390	1.145	1.070	.295	.347	.101	.711	.138	71.095	Oak land (bottom).
421	"	2.089	3.200	2.885	4.370	1.715	.520	1.044	.245	.261	.041	.393	.068	87.595	Cane land "
422	"	3.457	8.475	6.599	9.685	6.240	1.170	1.155	.320	.294	.067	.758	.232	73.645	"Gum soil" "
423	"	8 957	9.475	9.527	10.185	6.765	1.610	1.837	.170	.367	.101	.854	.054	70.370	"Buckshot land" (bottom).
424	Jefferson,	11.050	3.325	6.568	1.149	1 940	2.245	.929	.295	.391	.110	.502	.111	85.545	New field soil.
425	"	2.116	3.550	2.384	6.060	3.490	.295	1.100	.095	.193	.041	.441	.107	85.745	Subsoil.
426	"	4.160	7.850	7.379	9.995	5.965	1.370	2 871	.145	.351	.050	.898	.149	71.980	Red "buckshot" soil.
427	"	3.809	8.350	5.511	10.335	7.000	1.345	2.513	.345	.457	.067	1.013	.175	71.165	Subsoil.
428	"	6.092	8.435	7.879	11.360	6.815	.995	2.577	.195	.328	.135	.941	.125	70.240	Elm, oak, and hickory land.
429	"	3.098	5.200	6.750	6.560	4 615	1.095	1.292	1.170	.258	Not estimated	.710	.147	78.990	"Polished" cotton soil.
430	Monroe, (continued)	2.617	2.550	3.463	3.037	1.965	.220	.831	.245	.221	"	.386	.034	89.415	Virgin soil.
431	"	3.173	2.435	3.397	3.735	2 415	.420	.915	.345	.146	"	.401	.034	88.740	Cultivated soil.
432	"	1.342	2.800	2.546	4.485	2.940	.195	.382	.195	.299	.154	.227	.075	88.165	Subsoil.
433	"	1.944	3.300	3.748	3.435	2.465	.195	1.263	.245	.165	.075	.217	.069	88.490	Little prairie soil.
434	"	1.633	3.125	2.374	4.885	2.790	trace.	.504	.195	.129	.060	.290	.075	88.395	Subsoil.

435	"	2.039	5.750	4.296	9.820	5.315	0.145	2.735	.170	.251	060	.338	.153	76.495	Red clay.
4	Phillips,	7.783	11.225	14.390	6.802	5.485	2.378	1.721	.200	.303	.165	.493	.108	67.542	Virgin (bottom) soil.
437	"	2.945	9.400	7.588	10.360	6.340	2.620	1.941	.220	.491	.110	.852	.279	70.320	Cultivated (bottom) soil.
438	"	2.709	9.475	5.5[illegible]	9.600	6.840	1.620	1.703	.220	.314	.084	.777	.214	73.220	Subsoil (bottom).
439	"	6.423	4.150	5.555	3.870	2.965	1.055	2.057	.220	.297	.075	.347	.108	84.840	Virgin (ridge) soil.
440	"	2.270	3.300	3.231	2.460	3.115	.975	.989	.270	.253	.060	.391	.175	88.864	Cultivated (ridge) soil.
441	"	1.483	2.325	1.6[illegible]9	3.385	2.710	.845	.746	.220	.259	.050	.304	.156	90.400	Subsoil (ridge).
442	"	4.980	3.425	5.300	2.970	1.640	.595	.359	.395	.444	.079	.220	.004	88.450	Virgin soil (table land).
443	"	1.636	1.550	1.929	2.175	2.190	.270	.393	.220	.192	.060	.217	.064	92.290	Old field (table land).
444	"	1.295	4.700	3.462	8.110	5.465	.520	.783	.195	.332	.040	.432	.141	81.900	Subsoil (table land).
445	"	2.917	2.175	3.148	2.735	1.950	.330	.618	.425	.242	.050	.246	.117	90.790	Virgin soil.
446	"	2.300	2.150	2.931	2.860	1.750	.420	.664	.725	.194	.041	.164	.048	90.290	Old field soil.
447	"	1.447	2.000	1.719	1.719	2.290	.445	.357	.290	.193	.080	.188	.012	91.790	Subsoil.
448	"	3.933	1.900	1.835	1.835	2.615	1.020	.828	.395	.209	.024	.270	.104	90.615	Gen. Pillow's land.
449	St. Francis,	6.925	5.325	8.555	3.835	2.125	1.345	.494	.370	.555	.08[illegible]	.246	.032	83.390	Virgin soil.
450	"	2.967	2.600	3.619	3.035	2.340	.470	.532	.390	.210	.067	.261	.046	89.790	Old field soil.
451	"	2.061	2.200	1.893	3.710	2.515	.770	.566	.415	.144	.033	.285	.066	90.240	Subsoil.

CHEMICAL ANALYSES

MADE FOR THE

GEOLOGICAL SURVEY

OF

ARKANSAS.

BY

WILLIAM ELDERHORST, M.D.

The accompanying "Results of Chemical Analyses," made by Dr. Elderhorst, Professor in the Rensselaer Polytechnic Institute, were found among the papers of the late State Geologist.

It is supposed they were originally designed to be incorporated in the main Report; but, in default of information on this subject, and of an opportunity now to refer to that Report, already nearly through the press, the Administrator deems it his duty to forward these analyses for publication.

He has also received a map of Fourche Cove, Pulaski County, Arkansas, executed by Joseph Lesley, of Philadelphia, Topographical Geologist, whose Report is already printed.

The concentric lines exhibit successive elevations of ten feet each; and distinctive geological formations speak to the eye in contrasted but harmonious coloring. Had the Administrator felt himself justified in doing so, he would have had 5000 copies photolithographed to accompany the printed Report; but not being fully informed regarding the exact state of the fund appropriated for printing, illustrating, &c., he considered it best to forward the map to the Legislature of Arkansas, in order to give an idea of the manner in which, according to the views of his late brother, topographical work should aid and verify Geology and Palæontology, in all the important regions examined.

RICHARD OWEN,

Administrator on the estate of Dr. D. D. Owen, late State Geologist.

New Harmony, Indiana,
24th December, 1860.

RESULTS OF CHEMICAL ANALYSES,

FOR THE GEOLOGICAL SURVEY OF ARKANSAS.

No. 60. Qualitative examination of a hard, grayish rock containing metallic veins; found by Mr. Sloan on the Ouachita River, near Sulphur Creek; result communicated to John Adamson, Esq., Little Rock, Arkansas, the 13th December, 1858.

Result. Chert, with traces of CaO, containing particles and veins of iron pyrites.

No. 61. Qualitative examination of a black, pisolitic rock, very heavy; found four miles west of Bentonville, Benton County, Arkansas; result reported to R. E. Doak, Maysville, Benton County, the 13th December, 1858.

Result. Iron pyrites, with earthy and organic matter.

No. 62. Qualitative examination of a shell-marl; color green, structure granular, containing numerous small shells; found six miles south or southwest of Pine Bluffs, Bradley County; result reported and directions for use as a manure given to John Marks, Eagle Creek P. O., Arkansas, the 13th December, 1858.

Result. Carbonates of $\dot{C}a$, $\dot{M}g$, $\dot{F}e$, $\dot{M}n$; KO, NaO, and PO^5 (in not inconsiderable quantities); insoluble silicates.

No. 63. Qualitative examination of water from a mineral spring on the property of P. M. Johnson, Ozark, Franklin County, Arkansas; result communicated to P. M. J., December 13th, 1858.

Result.

Bicarbonate of Lime, } considerable quantity.
" Magnesia, }
Chlorides, not inconsiderable quantity.
Sulphates, small quantity.
Alkalies, doubtful.

I had only about four ounces of water to experiment upon.

No. 64. Quantitative analysis of the water of White River, Arkansas; taken about three hundred yards above Jacksonport.

Result. Reaction neutral; contains in 1 litre (1000 grammes by weight):

Silica,	0.011000 grammes.	Potassa,	0.002870 grammes.
Sulphuric Acid,	0.002748 "	Soda,	0.001490 "
Chlorine,	0.004302 "	Iron,	trace.
Lime,	0.060725 "	Manganese,	trace.
Magnesia,	0.033787 "		

The total residue was found to be, by a separate experiment, 0.1904 grammes.

No. 65. Quantitative analysis of the water of Black River, Arkansas; taken about three hundred yards above Jacksonport.

Result. Reaction neutral; contains in 1000 grammes:

Silica,	0.015300 grammes.	
Sulphuric Acid,	0.048167 "	
Chlorine,	0.005884 "	
Mn^3O^4+trace of Iron,	0.001300 "	
Lime,	0.058300 "	
Magnesia,	0.042688 "	
Potassa,	0.037940 "	determined by indirect analysis.
Soda,	0.030460 "	determined by indirect analysis.

The total residue was found to be, by a separate experiment, 0.3394 grammes.

No. 66. Quantitative analysis of "Incrustation deposited in wooden tubes (now out of use) through which the water from the Hot Springs on the hill was conducted to the bath-houses." Hot Springs, Arkansas.

Composition, dried at 250° F.

Carbonate of Lime,	95.620
Sulphate of Lime,	0.085
Carbonate of Magnesia,	3.060
Carbonate of Iron,	0.210
Carbonate of Manganese,	0.190
Potassa,	0.107
Silica,	0.119
	99.391

N. B.—0.107 grammes of KO require 0.1026 SiO^3 to form $KO.SiO^3$.

No. 67. Quantitative analysis of "Tufa from southwest slope of hill below No. 1. Hot Springs, Arkansas."

Composition, dried at 250° F.

Carbonate of Lime,	96.550
Silica,	0.773
Sesquioxide of Manganese,	0.920
Sesquioxide of Iron, with a little Al^2O^3,	0.395
	98.658

N.B.—6.920 grammes Mn^2O^3 correspond to 1.338 grammes $MnO.CO^2$. 96.55 grammes CaC contain 42.482 grammes CO^2; a direct carbonic acid determination gave 42.515 per cent.

No. 68. Analysis of a gypseous marl, labelled, "Selenite in matrix of clay, near Mr. J. W. Payne's, Township 21, Range 7 west, Greene County, Arkansas."

A qualitative examination showed the presence of clay, gypsum, magnesia, alumina, iron, potassa, small quantities of manganese, and phosphoric acid; on treatment with caustic potassa, the substance evolves ammonia: hence either AmO or organic matter must be present:

The quantitative analysis was confined to the determination of gypsum, water, and clay.

Composition, dried at 225° F.

Clay (Insoluble Silicates),	85.025
Gypsum,	6.610
Water and Organic matters (AmO^3),	7.106
Other soluble constituents,	1.259
	100.000

No. 69. Quantitative analysis of a Manganese ore, found near Batesville, Arkansas (so-called "Button-ore").

Composition, dried at 260° F.

Sand and Insoluble Silicates,	11.956
Manganoso-Manganic Oxide (Mn^3O^4).	64.838
Sesquioxide of Iron, with a little Al^2O^3,	1.744
Carbonate of Lime,	15.870
Carbonate of Magnesia,	0.886
Phosphoric Acid,	2.349
Cobalt,	trace.
	98.334

No. 70. Quantitative analysis of water from the so-called "Arsenic-spring." Hot Spring, Arkansas.

Contains in 1000 grammes:

Silicates,	0.045600	grammes.	
Sulphuric Acid,	0.019400	"	
Chlorine,	0.002275	"	
Mn^3O^4, with trace of Iron,	0.002000	"	
Lime,	0.059024	"	
Magnesia,	0.007629	"	
Potassa,	0.001560	"	} by indirect analysis.
Soda,	0.004650	"	

The total residue was found to be, by a separate experiment, 0.19825.

Two hundred grammes of the tufa from this spring were examined for arsenic and other metals, which are precipitated by HS, but none were found.

A portion of the water was examined for iodine and bromine, but none was discovered; perhaps the quantity operated upon was too small.

The "silicates," which were left undissolved on treating the residue, obtained by evaporating the water to dryness in a platina capsule with HA, were fused with a mixture of carbonate of soda and potassa, and qualitatively examined; found silica, lime, magnesia, iron, manganese.

For want of material the relative proportions could not be determined.

No. 71. Qualitative examination of the water from "Fairchild's Chalybeate Spring," Hot Spring County (?), Arkansas.

Sulphates, large quantity.	Magnesia.
Chlorides, small "	Manganese.
Lime, large "	Soda, strong reaction.
Iron, large "	Potassa, doubtful trace.

No. 72. Qualitative examination of "Bog iron ore, two and a half miles east of Purdon's, eight miles northeast of Little Rock, Pulaski County, Arkansas."

Sand and Clay, considerable.	Phosphoric Acid, comparatively large amount.
Iron, considerable.	Lime, small quantity.
Alumina, not much.	Magnesia, small quantity.
Manganese, comparatively large amount.	Baryta, trace.

No. 73. Qualitative examination of a black ferruginous shale, from Clear Creek, at Ruddle's Mill, Independence County, Arkansas.

Sand, small quantity.	Phosphoric Acid, pretty large amount.
Carbon, considerable quantity.	Alumina, minute quantity.
Carbonate of Lime, the main constituent.	Magnesia, " "
Iron, pretty large amount.	Sulphuric Acid, trace.
Manganese, pretty large amount.	Potassa, doubtful trace.

BOTANICAL AND PALÆONTOLOGICAL REPORT

ON THE

GEOLOGICAL STATE SURVEY

OF

ARKANSAS.

BY

LEO LESQUEREUX.

To Dr. D. Dale Owen,

Director of the State Geological Survey of Arkansas.

Dear Sir: In presenting to you my Report on the Geological State Survey of Arkansas, allow me briefly to review the instructions which I received from you, concerning the researches I had to pursue, as the Botanist and Botanical Palæontologist of the Survey.

In Fossil Botany, I was directed, 1st, to examine the plants of the coal and associated strata, with a view to finding, if possible, evidence of the age, number, and distribution of the coal-beds of Arkansas.

2d. To examine, for the same purpose, the fossil remains of plants accompanying the lignite formation, and to determine the age of these strata, either quaternary, tertiary, or cretaceous.

3d. To make a comparison between the Fossil Flora of the true Coal-Measures of the Millstone Grit or Subconglomeratic Coals, and of the more recent lignites.

Concerning recent Botany, the directions were:

1st. To examine the general distribution of the natural families of living plants of Arkansas, and mark the species peculiar to certain localities, especially and carefully studying and enumerating the plants inhabiting the Mammoth Spring of Fulton County, and those found around and within the Hot Springs.

2d. To investigate the geological distribution of the plants, or to mark the plants which characterize certain geological horizons.

3d. To examine the agricultural peculiarities of each botanical zone, and to give a popular description of the most useful species of plants in agriculture, medicine, &c.

4th. To make a list or catalogue of the plants of Arkansas, as far as time and opportunity might permit.

During the short time allowed me for exploration, I have endeavored to follow these instructions to the best of my ability. In company with Prof. E. T. Cox, a friend to whom I am already under many obligations for kind and valuable assistance, I entered Arkansas, with Camp No. 2, near the Mammoth Spring of Fulton County, on the 15th of October. The lateness of the season, and the consequent hurry of our explorations, did not permit me as long and favorable a study of the living botany of Arkansas as I should have liked. This has unavoidably caused some deficiency in that part of my report treating of the distribution of living plants in Arkansas. But I have endeavored to complete in a manner the catalogue of plants, by enumerating, along with the species observed by members of the Survey and by myself, those which I have found mentioned by former botanical explorers in Arkansas.

Very respectfully yours,

LEO LESQUEREUX.

INTRODUCTORY REMARKS.

The progress of the civilization of a people or of a country is marked by the development of its industry. In this century, the active power of industry is steam. Man is no more a machine—an instrument. His mind has subdued matter, has moulded it into the most complicated and diversified forms, has truly animated it, giving it power, strength—indeed life, by the wonderful application of steam. The true generator of steam is coal. Thus, a country is more likely to take the lead in industrial development, and therefore in civilization, if it be provided with a large amount of this combustible mineral. No political economist now would dare to estimate the present or future riches of a people, and their resources, without taking for a basis of his calculations its facilities for procuring a supply of coal. Even some of the most celebrated geographers and philosophers of our time have asserted that the Continent of North America, and especially the great valley of the Mississippi, would, at a future day, become inhabited by the densest and most civilized population of the world, because it has, in its extensive coal-fields, the largest amount of coal, that originator of industrial life.

Everybody is now acquainted with the general distribution and extent of the great coal-basins east of the Mississippi river. The great Appalachian basin occupies part of Pennsylvania, Ohio, Virginia, and Kentucky; its western limits being marked by a line running nearly due southward, passing near the mouth of the Scioto river, in Ohio. The Illinois coal-fields cover parts of Indiana, of Western Kentucky, of Illinois, throwing out spurs into Missouri, Arkansas, and farther west. The more the spurs are removed from the centre of the coal-basin, or from its most productive part, the more the coal which they contain becomes valuable, from the scarcity of the combustible mineral. This shows the great value of the coal strata of Western Arkansas, and the advantage that would result to the State from an extensive and rich coal-deposit. Not only the navigation of the Arkansas river would, at a future time, depend upon it; but it would supply with combustible material the inhabitants of the western

prairies, and direct the future construction of railroads, which are generally attracted by the coal, as by a powerful magnet.

It was, therefore, with a due consideration to the interests of the State that the Governor of Arkansas, and the State Geologist of the Survey, ordered that researches should be made to reconnoitre carefully the extent of the coal-basin of Arkansas, and its capacity, or the number of coal-strata which it contains in the whole thickness of the measures.

The coal-measures of the United States, at least in the places where they have received their full development, appear divided into four members by three different and thick strata of sandstone. The upper member rests upon a stratum named, in the Reports of the Kentucky Geological Survey, the *Anvil-Rock* sandstone, and contains some coal-beds, which are apparently extended over a wide area, but which until now have not been found of workable thickness. The second member in descending order is underlaid by the Mahoning sandstone, another great sandstone, sometimes conglomeratic in its upper part. This member, four to five hundred feet in thickness, contains, especially in Pennsylvania, the great Pittsburg coal-bed, and in Kentucky as many as five workable beds of coal, one of which, corresponding, by its position, with the Pittsburg coal, is generally from four to five feet thick. The third member, of about the same thickness as the former, lies between the Mahoning sandstone and the Millstone Grit series, or Conglomerate Formation, and contains also from four to six workable strata of coal, one of which is generally from four to six feet thick. This Millstone Grit, a variable formation, considering either the thickness or the nature of its strata, has been considered as the base of the true coal-measures, and the coal-bearing strata underlying it have been named by some geologists *the False Coal-measures.* But the examination of these strata, and the comparison of the fossil plants found in connection with them, tend to prove that this fourth member which descends from the base of the Millstone Grit to the Subcarboniferous Limestone, cannot be separated from the whole of our coal-formations; that it is a *true* member of them; that in some countries it contains two or three workable beds of coal, which can be as profitably worked as any bed of the other members.

As has been reported in the first volume of the Geological State Survey of Arkansas, all the coal-beds of the State appear to belong to the lowest member of the coal-formations, underlying the Millstone Grit. At least, all the hills or mountains at the base of which coal-strata have been found in Arkansas, are formed of shales and of various kinds of sandstone, all belonging to the Conglomerate Series, which reach here a great thickness. Even at the top of the highest mountains, I have failed to discover a trace of the coal or of the other measures which follow the Millstone Grit in ascending order. This cannot lead to the conclusion that the prospect for

good workable beds of coal is not encouraging in Arkansas. Near the western limits of the coal-basin, the Millstone Grit and the underlying strata take apparently a great development, and thus coal may be found there, at least one bed of it, as thick as in the higher series of the formation. Moreover, the extraordinary horizontality of the geological measures in Western Arkansas, causes an extensive distribution of the strata containing the coal, either near the surface or at a depth where the combustible material may be easily reached. Coal has already been found and surveyed in twelve counties, and just in those that are farthest from the great coal-basin which extends east of the Mississippi. The combustible mineral, thus rendered more valuable, becomes still more so from the situation of the coal-basin along the Arkansas river, and on both sides of it. Washington, Crawford, Sebastian, Franklin, Scott, Johnson, Yell, Pope, Perry, Conway, White, and Pulaski Counties are all of them almost entirely situated in the coal-basin of Arkansas, and its productive strata may yet be extended into some of the adjacent counties.

WASHINGTON COUNTY COAL, AT FAYETTEVILLE.

My examination of this place was directed first to a thick bed of black shales, exposed about twelve feet thick, below Cato's springs. These shales were supposed to belong to the true coal-measures, and to contain a bed of coal, which might be found by boring at some depth. They are of a coarse texture, somewhat micaceous, and do not show any trace of fossil plants. Their horizontal surface is only marked by ripples, evidently caused by the movement of the water at the time of their formation, and by long, irregular, depressed, and transversely wrinkled lines, half an inch broad, which are prints left by the progress of worms, or, rather, of small crustaceæ. These peculiar marks are found in great abundance in the upper beds of the Old Red Sandstone of Pennsylvania. Thus, by analogy of the palæontological remains, these shales are referred to the Subcarboniferous strata of the West, which, in part, take the place of the Old Red Sandstone of the East.

On the western side of the town of Fayetteville, and at a higher geological level than the black shales of Cato's springs, there are two outcrops of coal, which indicate, by their dirt, thin and scarcely valuable beds. None of these coal-beds have been opened. The lowest, just under a stratum of limestone, and said to be one foot thick, could not be examined. The other immediately overlying the same limestone, from which it is separated by a bed of fireclay, is supposed to be of the same thickness although its outcrop does not show more than one or two inches of coal. It is overlaid by a thick stratum of soft, grayish, or yellow shales ("soap-

stone"), which do not apparently contain any other fossil plants but some leaves of *Lepidodendron*, resembling long blades of grass.

Though the examination of these coal-beds was unsatisfactory, since they were not opened and exposed to view, I have no doubt that the upper one overlaid by "soapstone" is the first coal below the Millstone Grit, generally the only one developed at this geological station. It is ordinarily overlaid by soft yellow shales, containing pebbles of carbonate of iron or clay iron ore, and marked by remains of fossil plants, of which the most common species, and often the only one present, is *Lepidophyllum;* that is, those leaves of *Lepidodendron* mentioned above.

The shales of this coal are remarkably variable, either in their color, or hardness of texture, according to the amount of bitumen or of iron deposited while in the process of formation. On banks where they are exposed at some length, one can see them insensibly passing from a yellow soft soapstone mixed with clay iron ore to hard black shales, generally more or less abundantly intermingled with pebbles of carbonate of iron, which have mostly the form and the size of hen's-eggs. Sometimes these shales are so thoroughly penetrated by oxide of iron, that they constitute a hard and valuable iron ore. It is necessary to observe these changes in the appearance of the shales of the subconglomeratic coal-beds in order to account for the difference which may be found at various localities.

The beds of coal at Fayetteville, though thin at the place where they crop out, may be found in close proximity to it, have a thickness of two feet, or perhaps more. But it would be useless, I think, to search anywhere in Arkansas for a bed of coal below the Archimedes Limestone, which is exposed at the base of the hills near the town. And as the Millstone Grit formation does not, apparently at least, contain any limestone, the presence of a stratum of this nature may at once be accepted as an indication that coal in Arkansas cannot be found at a lower level.

MALE'S COAL-BANK. HIGHER WATERS OF MIDDLE FORK OF WHITE RIVER.

Ascending from Fayetteville to the top of the hills, on the higher waters of the middle fork of White river, near Mr. Hubbert's farm, a very interesting section is exposed from the base of the Subcarboniferous measures to the upper part of the Millstone Grit series.* There, about one hundred feet below the strata which mark the base of the Millstone Grit, and from which it is separated by two beds of Subcarboniferous Limestone with intervening blue shales, shaly sandstone and chert, there is a thick stratum of coarse sandstone containing plants of the true coal epoch, viz., species

*See Mr. E. T. Cox's Report, hereafter.

of *Stigmaria*, *Calamites*, *Sigillaria*, &c. It is probably from an equivalent geological horizon that a great number of beautiful plants of the same epoch have been obtained by the State Geological Survey of Illinois, in a bed of sandstone underlying the first upper Archimedes Limestone; an interesting fact, showing the beginning of the vegetation of the coal at a time when the plants had not been heaped up for the formation of the combustible matter, and exhibiting at the outset species bearing no relation to those of inferior strata, or to those of the Old Red Sandstone.

The coal-bank at Mr. Male's is only eight to ten inches thick; but apparently of excellent quality. It is generally overlaid by a bed of gray, hard, somewhat micaceous soft shales, which contain, besides the leaves of *Lepidodendron*, a great quantity of beautifully preserved remains of plants.* As the coal-bank where we examined it, was worked by stripping the surface, a trench of some length had been opened through the strata overlying it, and had exposed one of those curious changes to which I have alluded above. At one extremity of the trench, the shales, two feet thick, have their normal appearance; they are gray, soft, or black, and bituminous near their contact with the coal. At the other extremity, and by short transitions, they have passed into a kind of ferruginous limestone, or rather conglomeratic iron ore, which is the base of the Conglomerate series overlying this coal. The same stratigraphical distribution, and even the same changes in the nature of the shales, have been reported for the Geological State Survey of Kentucky; at the coal-bank of McCormic, near the western limits of Morgan County, where the Subconglomerate coal, sixteen to twenty feet thick, is, at one place, overlaid by soapstone; at another by black hard ferruginous shales, and at a third opening, immediately by conglomerate, the shales disappearing totally.

About one mile from Mr. Male's coal-bank, another opening (Gallion's bank) has been made in the same bed. The thickness of the coal is the same. Time did not permit us to visit it.

WOTON'S COAL-BANK. HEAD WATERS OF LEE CREEK.

Section 34, *Township* 13, *Range* 31.

The coal, ten inches thick, is here also placed at, or very near the base of the Millstone Grit series, being only separated from it by the overlying shales, and being separated from the upper Archimedes Limestone by twenty-three feet of sandstone and fireclay. At two openings of this coal the shales that cover it are still very different in appearance. At one

* The enumeration of these plants is given in the Table, further on.

place, the coal is overlaid by seven to eight feet of grayish-yellow, soft, very brittle shales, full of remains of plants. At the top of the shales appears another bed of coal a few inches thick. Near by, the shales overlying the coal are fifty to sixty feet thick, and black, micaceous, with very few prints of plants, if any. The second bed of coal is not formed at this last opening. Down the creek, the shales become in places yellow, hard, and half transformed into carbonate of iron and clay ironstones. This conformation is still in accordance with what has been reported of the Sub-conglomerate coal of Morgan County, Kentucky, where Well's coal-bank, twenty-two inches thick, is separated from another thin bed of coal, five to six inches thick, by sixteen feet of black shales. This leads us to remark that as, occasionally, the shales covering the coal are not present, and the coal is immediately covered by the conglomerate, so in like manner, when two beds of coal have been formed, the intermediate shales may thin in such a way that both coal-beds become united in one, being only separated by a clay parting.

In descending Lee creek and entering Crawford county, ten and a half miles below Woton's coal-bank, we found in the creek large pieces of sandstone covered with *Fucoides cauda-galli*, a kind of fossil plant said to be peculiar to the Chemung group, or Upper Devonian. As the general dip in that part of the country is to the southwest, or in the same direction which we were following, the presence of this Devonian species appears here an anomaly, and can only be explained by some peculiar disturbance of the strata, or rather by the supposition that this species has a much wider range of distribution than had till now been supposed. In some places, along the margins of the eastern coal-basin of Kentucky, the Conglomerate is sometimes immediately underlaid by this formation of the *Fucoides cauda-galli*.

CRAWFORD COUNTY. MR. PHILIP'S COAL-BANK, NEAR FROG BAYOU.

Except the nomenclature of the fossil plants found in connection with this coal there is scarcely anything to add to the exact description given of it by Professor E. T. Cox, page 226 of the first Report. The shales overlying the coal are about twenty feet thick, and generally black or grayish-blue, hard, micaceous, very bituminous in their approach to the coal, where they only contain remains of fossil plants. From top to bottom they are intermixed with pebbles of carbonate of iron in abundance. The vegetable remains of these shales are mostly those of *Cordaites borassifolia* (Ung.), a plant which covers, or apparently constitutes the shales for about two feet of their thickness. The leaves of the species, which were long and ribbon-like, filled alone great spaces of the marshes of the coal

formations, just as the water-lily or the spatterdock does the swamps of our time? The relation of this plant is still uncertain. Some of the numerous and large fruit, found in the shales of the coal, have been referred to this species, apparently without reason; for the shales which have preserved the greatest quantity of these leaves contain scarcely any remains of fruits.

SEBASTIAN COUNTY, JENNY LIND PRAIRIE. MR. GREEN'S COAL-BANK.

From the strata of red ferruginous or ochreous clay shale, which generally mark the base of the Millstone Grit series in Arkansas, and which crop out at the base of the hills bordering the prairies, the position of this coal, as Subconglomeratic, becomes at once evident. As the shales of this coal do not show the same general appearance as at the other localities where it was examined, this stratigraphical conclusion is of some value. The shales look like a compound of yellow clay and ironstones mixed together. They break crosswise or perpendicularly rather than horizontally, and are separated by irregular bands or thin veins of clay more deeply colored with oxide of iron and extremely brittle. The fossil plants contained in this peculiar kind of shale are tolerably numerous, but they are generally broken and difficult to determine. The species which would be recognized, and which are enumerated in the table, strengthen the conclusion which places this coal at the same geological horizon with those above. The coal, here, is four and a half feet thick, and has two clay partings of about one inch each. But the top coal, for about one foot of its thickness, is a shaly or brashy coal of little value as a combustible. It looks like a brittle black shale intermixed with lamellæ of coal-matter and full of broken remains of plants difficult to determine. The presence of this brash coal is still a character which in some places may help the identification of the Subconglomeratic coal. In Indiana, the whole thickness of the bed corresponding to this one by its position, is at times only a compound of brash or black bituminous thin layers of shale, separated by alternate thin layers of coal. In Kentucky, the Subconglomerate coal-bed is generally, if not always, overlaid by a few inches of this kind of brash, which has to be separated from the true coal as useless.

JAMES' FORK OF POTEAU. MR. MORROW'S COAL-BANK.

At this place, there is not any difference in the appearance and the nature of the shale from what we described at Frog Bayou or at Male's coal-bank. The shales are gray, hard, somewhat micaceous, intermingled

with pebbles of carbonate of iron, and marked by a few fossil plants. The coal, three and a half feet thick, is like that of Jenny Lind prairie, overlaid by half a foot of brash, which contains a great abundance of fossil plants. They have been determined, and are enumerated in the Table. The species indicate the closest relation with those of Mr. Male's coal-bank. Thus, this coal of James' Fork, by the nature and composition of the shales, and by its brash coal, and by the identity of the plants which it contains, is like an intermediate link uniting all the coal-banks examined until now, or indicating their place on the same geological horizon. It has a number of the plants of Male's coal, especially the two species which I consider true characteristic plants of the Subconglomeratic coal in Arkansas, viz., *Alethopteris Owenii*, Sp. nov., and *Sphenophyllum bifurcatum*, Sp. nov., the first common also at Lee's Creek coal-bank. It has the shales of the same composition and appearance as those examined at Frog Bayou, as also the same plants, and the brash coal and the fossil species of Jenny Lind prairie coal.

The thickness of the two coal-banks examined in Sebastian County, compared with that of the coal strata of Crawford and Washington Counties, would perhaps indicate a progressive increase in the development of the subconglomeratic coal towards the south. Hence, the researches for workable beds of coal might be advantageously followed up, not only in Sebastian County but also in the southern part of Franklin and Johnson and in the northern part of Scott and Yell Counties.

FRANKLIN COUNTY, GRAND PRAIRIE. JUDGE ALDRICH'S COAL-BANK.

This bank has been worked occasionally to supply the wants of the blacksmiths of the country. It is still opened at some other localities in the neighborhood, and found nearly everywhere in the prairies of South Franklin, one or two feet below the surface. But where we had an opportunity of examining it, the coal had been covered up again, and nothing could be seen of it but a few pieces of shale thrown out from old ditches. This coal on Grand Prairie is generally eighteen inches thick, overlaid by hard, sandy, micaceous gray shales. The only fossil plant found in connection with them is *Calamites pachyderma*, Brgt., a species which, till now, has never been found but within or below the Conglomerate Series. Thus, though the examination of this coal was necessarily unsatisfactory from the want of exposed materials, the finding of this only species is sufficient to indicate its position as being below the Millstone Grit. Another evidence of the position of this coal was found in the nature of the strata overlying it; since just at the top of a small hill in the middle of Grand Prairie, and at about forty feet above an opening of this coal,

we found another coal-bed six inches thick, showing here the separation of the coal into two strata as it has been remarked at Lee Creek and Frog Bayou.

The composition of the black fire-clay underlying the Aldrich's coal, and the abundance of iron in the shales above it, indicate a contemporary formation of this bed with the others already mentioned. The hard fire-clay, blackened by roots of *Stigmaria*, is remarkably developed under the Subconglomerate coal. It is sometimes found alone and without coal, in such places where the combustible matter has not been formed.

On Hurricane Creek, the same coal is opened at Mr. Newton Carpenter's, where it is of the same thickness.

JOHNSON COUNTY, HORSEHEAD CREEK, MORISSON'S, WILMOTH'S, BUTT'S, LEE'S, AND OTHER COAL-BANKS.*

The general appearance of the shales of all these different coal-banks, which are evidently openings in the same coal-bed, are exactly the same as those of the coal of Frog Bayou and James' Fork. The only difference is, that sometimes the shales, as at Morisson's bank, become more bituminous, and insensibly pass to brash, near their contact with the coal. At Mr. Wilmoth's bank, where the shales are exposed in a thickness of about twenty feet, they are gray, micaceous, intermingled with pebbles of carbonate of iron, generally ferruginous, and with few remains of plants. The coal here, twenty inches thick (the same thickness as at the other openings of Horsehead Creek) is better than at Mr. Morisson's bank, where it lies nearer to the surface, and is consequently somewhat rusted and broken by percolation of water charged with oxide of iron. Among the few fossil plants found in the shales are some broken *Lepidodendron*, especially their leaves; *Neuropteris tenuifolia*, which was seen at every coal-bank examined in Arkansas, and *Cordaites flabelliformis*, Ung.

On reviewing with Mr. Cox his section (published page 231 of his first Report), and ascending to the highest point of Horsehead Creek Mountain, we found, by barometrical measurement (1150) eleven hundred and fifty feet of measures of the Millstone Grit series overlying this coal. The base of the series is here, as elsewhere in Arkansas, a compound of reddish and sometimes dark brown argillaceous shales, and the top a conglomerate sandstone. The hard, coarse sandstone covered with vermicular concretions (a peculiar kind of impressions, which have been mentioned in the first Report, page 114) is in place near the top of the Horsehead Creek Mountain. I had thus a good opportunity of examining these curious

* See description of these coal-banks in Mr. Cox's first Report, page 231.

marks, which generally look like large worms of sandstone, incrusted in a matrix of the same matter. But I was unable to discover in them any trace of organism, or any general typical form to which they could be referred. Their outline is very irregular; sometimes they appear long, linear, of equal thickness (generally half an inch) in their whole length; sometimes they are constricted, and apparently cut into pieces of unequal size; sometimes they are thicker, short, and even perfectly round. I suppose that they are pure mechanical concretions, formed by infiltration or percolation of water, charged with carbonate of lime or oxide of iron at the time when the sandstone was yet a soft sandbank. The extraordinary horizontal extent of the sandstone bearing these marks is nevertheless a fact apparently contradictory to this explanation; for it appears near the top of all the conglomerate hills of the coal-measures of Arkansas, when they are high enough to reach its geological horizon. But the nature of the overlying strata might have influenced the infiltration of foreign substances over a vast area.*

MOUTH OF SPADRA CREEK. SPADRA COAL.†

The shales covering this coal bear already, like those of the Horsehead Creek coal-bed, traces of a metamorphism which has hardened them and split them contrary to the plan of stratification. This renders them brittle, and causes under the stroke of the hammer irregular fractures which prevent the preservation of fossil plants. The shales are grayish or black, less micaceous than at Horsehead Creek, and more like those of Male's coal-bank. The few plants determinable in the broken pieces of shale are, *Neuropteris tenuifolia*, Brgt.; an abundance of leaves of *Lepidodendron* and *Lepidophyllum lanceolatum*, Brgt. The coal is overlaid by the same brash coal as that of James' Fork and other places, which contains especially in abundance *Calamites undulatus*, Brgt., and *Calamites pachyderma*, Brgt. These species, like the former, show the same geological horizon for this coal as for the other beds examined in Arkansas. At some places, near the mouth of Spadra Creek, the coal is three and a half feet thick, including a clay parting of three inches, and about six inches of brashy coal. It is still underlaid by the black, hard fire-clay full of leaves of *Stigmaria* which has been mentioned before. The same coal crops out above the town of Spadra, on the bank of the Arkansas River, where it is

* To give an idea of the difficulties attending a *botanical* exploration at this season of the year, I may mention that, on the 12th of November we ascended the mountain with a strong, cold north wind and snow.

† See description of this coal by the State Geologist, in the first volume of the Report, page 129.

said to be four feet thick. It is thus probable that the same coal will be found of workable thickness all around the country, when the combustible mineral shall become valuable enough to encourage exploration by borings. Clarksville, the county seat of Johnson, is built on an eminence, just at the top of the black shales overlying the Spadra coal. These shales may attain a thickness of fifty to sixty feet; but, as near the town the bank of shales is cut by the creek to the depth of thirty to forty feet, the coal, if it is formed there, would probably be found ten to twenty feet below the level of the creek.

The coal-bank of Dwight mission, in the same county, is the only one that was still in the way of our route, and the last which I was directed to examine. At our passage there it was covered by high water and could not be seen. But the great bank of shales exposed near the river, of a thickness of about sixty feet, shows, in its composition, the same materials which have been seen before. The shales have apparently the same composition, and contain in extraordinary quantity pebbles of carbonate of iron.

As a conclusion to this examination of some of the coal-banks of Arkansas it may be remarked:

That the value of the coal-beds of a country is necessarily relative, and cannot be estimated by comparison with the price or the value of the coal at another place. A bed of anthracite three feet thick is profitably worked, even by a shaft fifty to one hundred feet deep, in the basins of Pennsylvania, where numerous strata of the same combustible mineral are found and worked from six to nine feet thick, or more, and where millions of tons are every year mined and brought to market. A bed of bituminous coal four feet thick is remunerative when worked all along the Ohio river from Pittsburg to Careyville, although, from an excessive competition, the coal is sometimes delivered to the boats at five cents per bushel, or even lower. In Arkansas, where the coal is semi-bituminous, or half anthracite, and consequently of higher value as a heating agent than the bituminous coal of the East; where also this combustible material, though still uncalled for by manufacturers, and used only for a few forges, is paid at the bank from ten to twenty-five cents per bushel, the coal has a much higher value. From data collected in statistical tables it results that a coal-bank like the Spadra's, three and a half feet thick, producing about three feet of clean coal, will hereafter, and when the demand for coal becomes more pressing, give to the owners more profitable results than a bank of nine feet of anthracite would give in the central part of the basin of Pennsylvania.

It is true that in Arkansas the working of the coal will never excite such speculation and employ such a capital as is necessary in or near the centre of the coal-basin. But from what is known already about the dis-

tribution of the subconglomerate coal in Arkansas, one has the right to assert that by and by coal will be found if not in very thick strata, at least abundantly enough to supply the wants of the future manufacturing establishments of the country.

To direct future researches it will be well to remember that the coal strata of Arkansas generally underlie, at a distance of fifty to one hundred feet, a bed of red ferruginous clay or red earth which is easily distinguished wherever it appears in the counties mentioned as included in the area of the coal-fields of Arkansas. It is also well to bear in mind that, although two beds of coal may have been formed in Arkansas, it is the lowest only which, up to the present time, has been found of workable thickness. The Subcarboniferous measures generally underlie it at a short distance, and no coal can be expected to be found within them.

DESCRIPTION OF NEW SPECIES OF FOSSIL PLANTS COLLECTED IN THE SHALES OVERLYING THE SUBCONGLOMERATE COAL OF ARKANSAS.

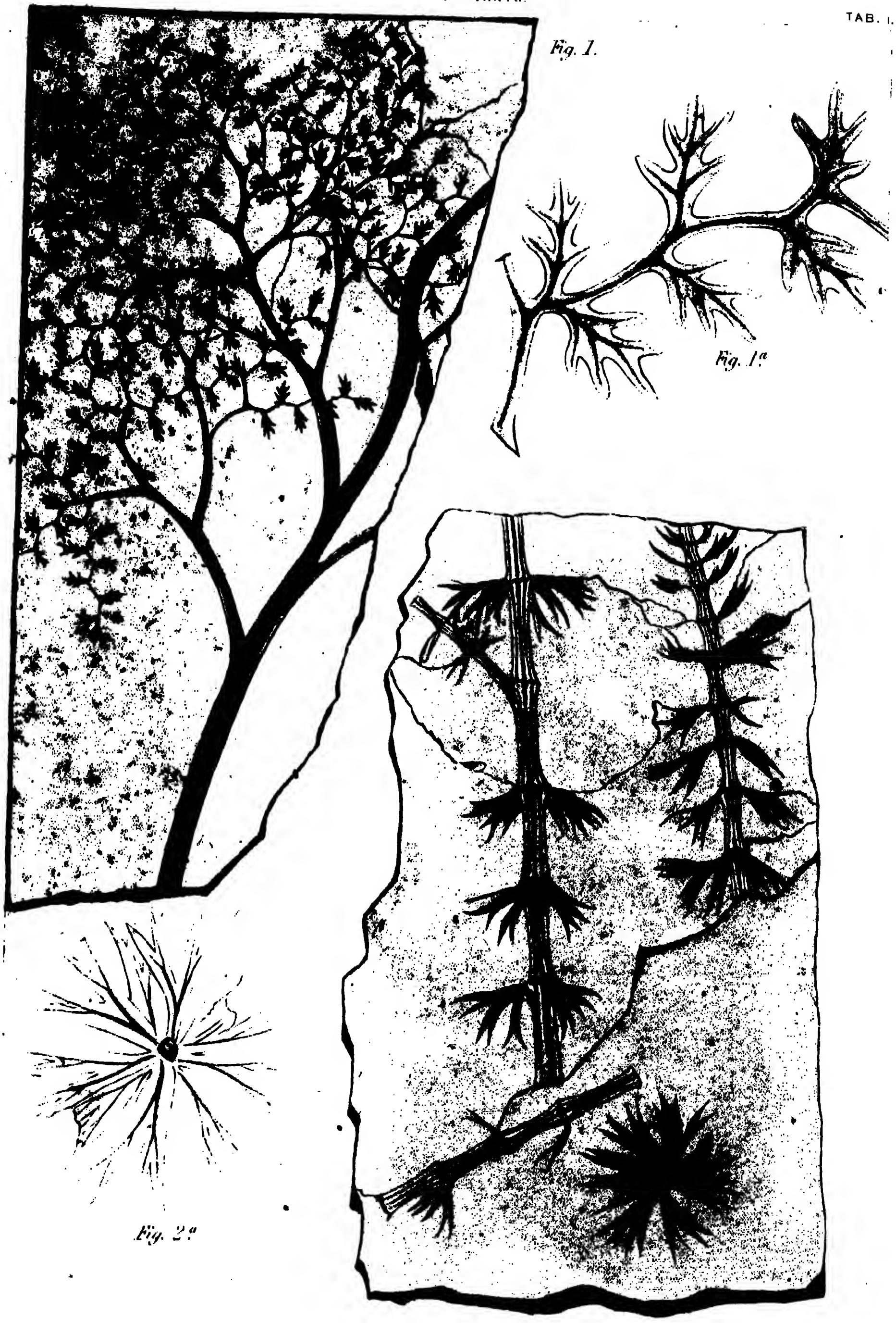
Two considerations favor a careful description of the fossil-flora of the coal of Arkansas:

1st. The practical utility of palæontology in its application to the identification of coal or any other geological strata.

2d. The peculiar position of the coal of Arkansas, so well developed at a geological horizon where until now the formation of a good workable bed of coal has been considered as problematical. It is evident that the ascertaining of the true place of this coal may direct researches for combustible mineral at a lower level than where they have been pursued till now in other States. Moreover, the scientific world at large is at present very much interested in trying to solve the question of the distribution of vegetation in the different geological strata of our globe, and to find links of union which may exist between species and genera successively appearing in various strata. It is worth while, therefore, to carefully collect and record all the data which may afford reliable indication to the limits of the flora of the true coal period.

The following short description of the new species of fossil plants found in connection with the shales overlying the coal of Arkansas is given without following the natural and botanical order, but only as an explanation of the figures of the plates. This report is not the place for long scientific discussions and for close and comparative descriptions. They would be useless to the reader who is not acquainted with fossil plants, and to the botanist they would reveal nothing new. For the same reason I omit describing the species already known which are common to the Subconglomerate coal and to the coal above the Millstone Grit.

TAB. I.



Leo Lesquereux del.

Dougal sc.

Fig. 1. & 1a. Hymenophyllites flexicaulis, Sp. nov.,
Fig. 2. & 2a. Sphenophyllum bifurcatum, Sp. nov..

These are enumerated in the table with a mention of the place where they have been found.

1. *Hymenophyllites flexicaulis*, Sp. nov. (Pl. 1, fig. 1 and 1 *a*). Frond much branched, four to five times pinnately divided. Divisions alternate. Primary and secondary rachis broad, flattened on the margins, inflated in the middle, somewhat regularly bent at each ramification. Branchlets exactly flexuose, bending in a zigzag way from the point of attachment of each leaflet, which thus appear as a continuation of the rachis. Leaflets oval-lanceolate in outline, small, scarcely an eighth of an inch long, palmately divided in three or four or pinnately in five lobes. Divisions linear-lanceolate obtuse, marked by a single medial nerve, decurrent in the branchlet. Fig. 1 *a* is an enlarged leaf of this fern which, though somewhat related to *Sphenopteris flexuosa*, Gutb., an European species, differs from it by well-marked characters. It abounds in the shales of Mr. Male's coal-bank on the Middle Fork of White River, Washington County.

2. *Sphenophyllum bifurcatum*, Sp. nov. (Tab. 1, fig. 2 and 2 *a*). Stem thick, branching, inflated at the articulations, deeply furrowed, smooth. Leaves in whorls of nine or ten cuneiform, or flabellate leaflets, narrowed near the base, dilated above, regularly divided two times. Primary divisions deeper; secondary ones lanceolate acute, diverging, each marked by a strong medial nerve ascending to the point. This species is distantly related to *Sphenophyllum dichotomum*, Germ. & Kaulf, and to *Sphenophyllum oblongifolium*, Germ. Though fragments of the different parts of the plant were found the form of the leaves does not show any variation. Fig. 2 *a* shows a whorl of leaves, enlarged two times. The leaflets appear united at the base but it may be an appearance of the stone. *Sphenophyllum trifoliatum* Lsqx., of the Pennsylvania State Geological Report, p. 853, tab. 1, fig. 7, may be referred to this species. Found in the shales of Male's coal and of James' Fork of Poteau.

3. *Alethopteris Owenii*, Sp. nov. (Pl. 2, fig. 1 and 1 *a*). Frond large, bi- or tripinnate. Rachis or stem broad, thick, nodose, striate. Secondary divisions or pinnæ perpendicular to the stem; pinnules ovate-lanceolate or lanceolate in some parts of the frond, generally obtuse, sometimes pointed, with undulate margins united near the base and perpendicular on the rachis. Medial nerve well marked, but generally thin, sometimes deep; nervules forking twice. This fine species, dedicated to Dr. D. Dale Owen, the celebrated geologist, director of the survey of Arkansas, abounds at Male's and also at Lee-creek coal, but was found only in broken pieces. It differs from *Alethopteris Coxiana*, Lsqx., its nearest relative, by narrower, less undulate or more entire leaflets, apparently thick and coriaceous, and by a general appearance total y different.

4. *Staphylopteris stellata*, Sp. nov. (Pl. 2, fig. 2, 2 *a* and 2 *b*). These remains apparently belong to the sporanges of a fern borne on a distinct

stem or pedicle. As it is shown in the figure, the spore-cases are oval or round, narrowly striated, united four or five together by short alternate branches perpendicular to the smooth main stem. Some branches appear longer than the point where the spores are attached, and thus may have been a common pedicle for a few groups of spores. Such fructifications of ferns, supported on a peculiar pedicle and distinct from the sterile leaves, are common enough in our time, but are very rarely found in the old formations. I do not know of another species found in the coal formations but this. The genus *Staphylopteris* was established by Mr. Brongnart on a species found in the tertiary.

5. *Sphenopteris dilatata*, Sp. nov. (Pl. 2, fig 3 and 3 *a*). Frond bi-pinnately divided. Pinnæ short, oval-lanceolate in outline; pinnules irregular, round or enlarged above and fan-shaped, decurring on the rachis, mostly united near the base. Medial nerve obsolete or none; nervules dichotomic or forking two times, arched and oblique to the medial nerve. By its peculiar nervation, which is like that of a *Neuropteris*, this species would be referable to the genus *Adiantites*, Göpp. Male's coal-bank.

6. *Asterophyllites gracilis*, Sp. nov. (Pl. 2, fig. 4 and 4 *a*). Stem narrow, thread-like; leaves in whorls, narrow, linear, pointed and marked by a medial nerve; the point generally upraised. Though I have found a few specimens of this species, they present all the same form and appearance as shown in the figure. The leaves, never flattened, are imbedded in the stone in such a way that the horizontal section shows only their thickness and their direction. Probably the figure only represents a branch of a somewhat larger species. The hardness of the leaves indicated by the peculiar disposition of all the whorls, separate it from all the other species of the genus. Locality, Male's coal-bank.

7. *Lepidodendron modulatum*, Lsqx. (Pl. 3, fig. 1 and 1 *a*.) Stem apparently of a great size. Scars oval, narrowed and acuminate at both ends, separated by a broad, half round, elevated and deeply furrowed or wrinkled margin. Wrinkles undulated and mainly parallel to the scars. Vascular scars rhomboidal, arched or obtuse above, narrowed at the base in a long depressed point, acute at both sides, marked with three transverse points. Tubercles narrow; medial line deeply marked and transversely furrowed by deep short wrinkles. Surface of the scars transversely, narrowly wrinkled; appendage double. This beautiful species was first found in the low coal of Carbondale, Pennsylvania; but only in some pieces of a large stem figured at 1 *a*. The specimen fig. 1 of Male's coal shows the exact preservation of the specific characters on a branch or on a young tree, and consequently fixes the validity of the characters presented by the scars of the bark of the *Lepidodendron*.

8. *Sigillaria reticulata*, Sp. nov. (Pl. 3, fig. 2). Surface reticulated by perpendicular furrows and horizontal deep wrinkles. Scars distant, nearly as

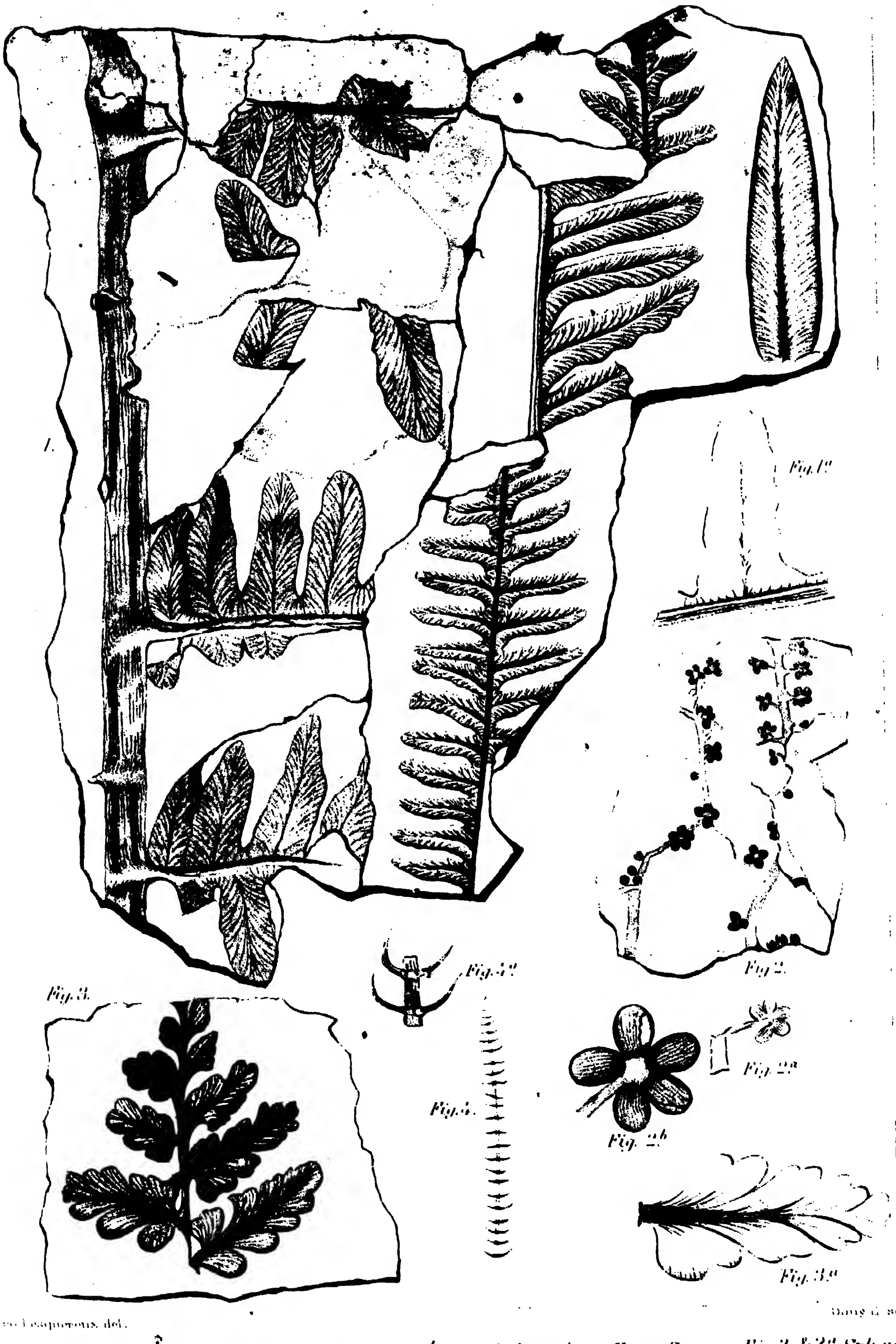
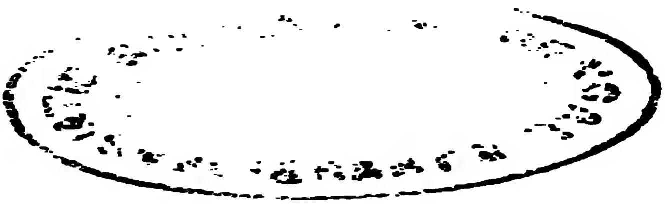
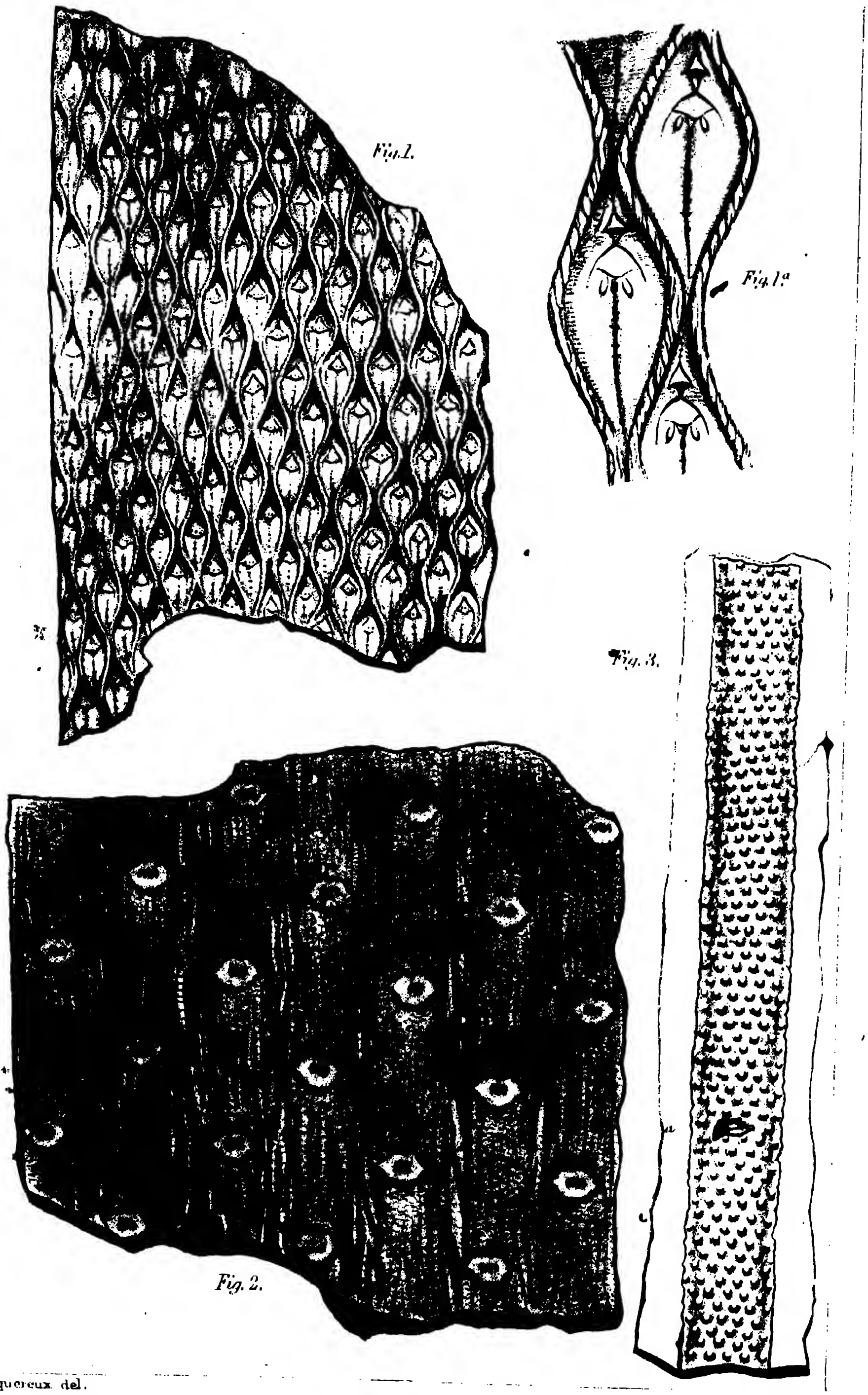


Fig. 1. Alethopteris Owenii, Sp. nov.. Fig. 2. 2a 2b Staphylopteris stellata, Sp. nov. Fig. 3. & 3a Sphenopteris dilatata, Sp. nov.. Fig. 4. & 4a Asterophyllites gracilis, Sp. nov..





Leo Lesquereux del.

Dougal sc.

Fig. 1. & 1.a Lepidodendron modulatum, Lsq.x Fig. 2. Sigillaria reticulata, Sp. nov.. Fig. 3. Halonia pulchella, Sp. nov..

high as broad, emarginate, cordate above, round obtuse below, with obtuse lateral angles. Vascular scars three, the medial one semilunar or round, the lateral ones straight or scarcely arched. Habitat, Male's coal-bank.

9. *Halonia pulchella*, Sp. nov. (Pl. 3, fig. 3). Stem apparently slender, straight, scarcely branching, marked by small elevated points or tubercles. Among the few species which have been published of this genus, and which apparently all belong to the subconglomerate coal, none presents as fine and as regular an appearance as this in the disposition of the tubercles. The depression marked at *a* is apparently the place of a branch. Locality: Male's coal-bank.

10. *Diplotegium truncatum*, Sp. nov. (Pl. 4, fig. 1). Stem apparently broad, marked by elevated, half-round, elongated, truncate scars, which are the base of broken leaves. These scars are regularly placed in spiral ½ rows. This species could be referred to a *Knorria* but for the abrupt and irregular fracture of the point of the scars. Locality: Male's coal-bank.

11. *Lepidodendron diplotegioides*, Sp. nov. (Pl. 4, fig. 2). In Mr. Corda's description of *Diplotegium Brownianum*, the decorticated part of the stem shows rhomboidal scars somewhat resembling those of this figure. It may thus be that the specimen described here is referable to the former species though the scars are very different. They appear related to a true *Lepidodendron*, nearly related indeed by the central scar to *Lepidodendron sigillarioides*, Lsqx. Till some better specimens are found, the name can be preserved. Found in the shales of Frog-bayou coal-bank.

12. *Lepidophloios irregularis*, Sp. nov. (Pl. 4, fig. 3.) Stem tree-like; bark covered with scales left by the base of the deciduous leaves; scars rhomboidal, irregularly placed and of various size, with a broadly rhomboidal small scar at its upper part, showing the place of attachment of the leaves, and marked by three vascular points. The specimen figured here is the only part found at Male's coal, except a still smaller specimen found at James's Fork of Poteau. The scales either covering part of the scars, or detached, are visible enough, apparently lacerated and reflexed. But the irregularity of the scars may be due to a mechanical action of compression or decomposition, and a larger piece of the species would be needed to indicate its true characters.

13. *Cardiocarpon ingens*, Sp. nov. (Pl. 4, fig. 4, and 4 *a*.) A large and beautiful fruit, heart-shaped in its general outline, deeply notched at the point and surrounded by a broad, narrowly striated margin. Though fig. 4 *a* is more pointed, it appears to represent the same species as fig. 4. Both were found at Male's coal, and a specimen like fig. 4 was found also at Frog Bayou.

14. *Cardiocarpon affine*, Sp. nov. (Pl. 4, fig. 5.) Perhaps this species represents an unripe or undeveloped state of the former. It is rounded at the base, pointed at the top, marked by a cordiform, basilar depression

which, in the specimen, is filled with a coaly matter, and which looks like the place of a kernel. The top is also marked by two diverging small hollows appearing like the two cotyledons of certain fruits of our time. This is said only concerning the form, and not to show any relation whatever between the fruits of the coal and those of the dicotyledonous plants which cannot belong to the coal. If by the ripening and the enlarging of this fruit the marked depressions became joined together, and if the outer envelope marked by the striated margin *a* was destroyed, we would have just the same form in this species as the one marked fig. 4. Hence the name given to it. It was found both at the same places and on the same shales as the former.

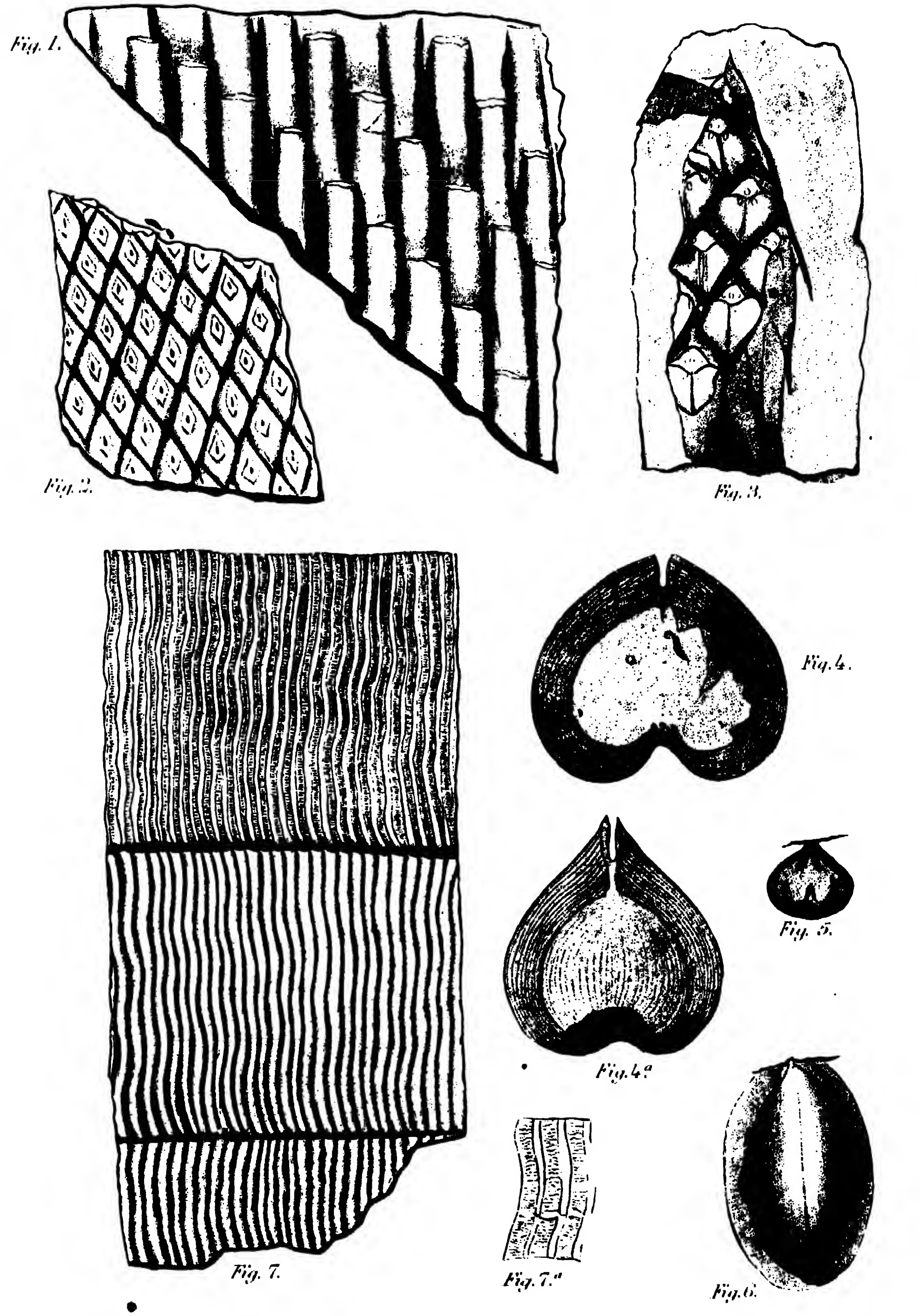
15. *Carpolithes platimarginatus*, Lsqx. This fruit has the form of an almond, and might be perhaps referred to *Carpolithes amygdalæformis*, Göp. & Berg. It has already been published in a different form for the Report of the State Geological Survey of Pennsylvania. The general outline is oval, but it is often enlarged at the base, more pointed above, and with a narrow margin or no margin at all. It was found at Male's coal-bank and Lee creek, and ascends above the Conglomerate; at least in Pennsylvania it was found in the lowest coal of Trevorton, between two beds of conglomerate.

16. *Calamites undulatus*, Sternb. (Pl. 4, fig. 7, and 7 *a*.) This species is common enough in America and in Europe, in connection with the lowest strata of the coal. It has been already published by different authors; but the articulations have never been figured and described; and as this species is considered by some as doubtful, or only as a variety of *Calamites cannæformis*, Brgt., it becomes, in the form in which it is published, as interesting as a new one. The ribs, in the natural and corticated state are smooth, irregularly undulated, separated by a deep smooth furrow. In the decorticated state, or when the carbonaceous pellicle which covers the stem is removed, the ribs appear nearly flat, marked by horizontal and numerous wrinkles separated by a broad smooth line (fig. 7 *a*). On the articulations which are deeply marked, the base of each furrow is marked by an oval point which is scarcely a tubercle, and which varies in its form and size.

17. *Sphenopteris decipiens*, Lsqx. (Pl. 5, fig. 1, and 1 *a*.) A bipinnately divided branch of fern with short, lanceolate, somewhat obtuse pinnæ and variable pinnules mostly round in outline. By the form of the leaflets this species has a great likeness to *Alethopteris nervosa*, Brgt., but differs by its peculiar nervation; the somewhat thick medial nerve running along the rachis to its point of attachment (fig. 1 *a*). The nervules of this species are generally obsolete and scarcely visible. In *Alethopteris nervosa* they are, on the contrary, deep and well-marked. Found at James' Fork of Poteau.

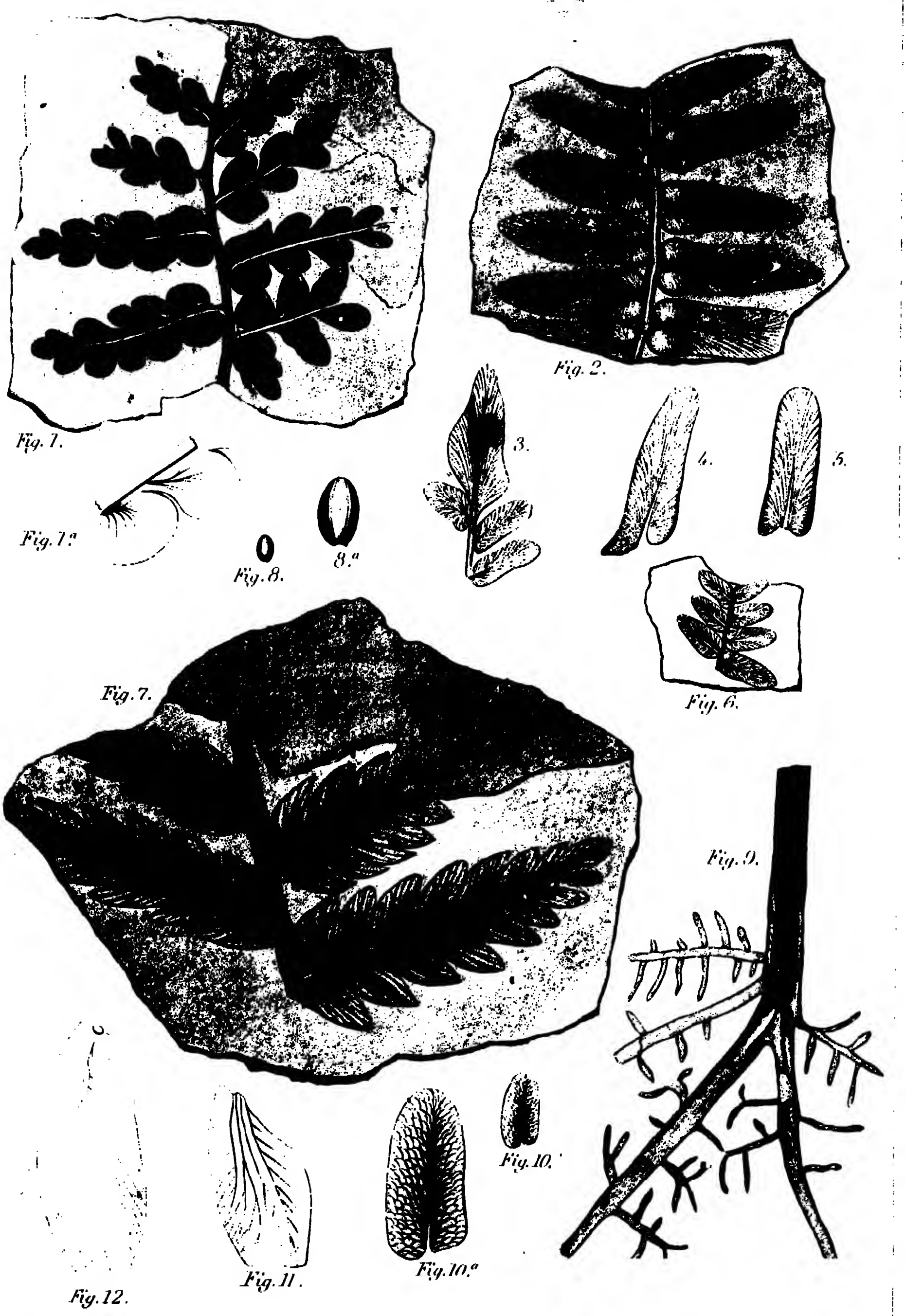
18. *Neuropteris tenuifolia*, Brgt. (Pl. 5, fig. 2 to 6.) Though this species

FOSSIL PLANTS. TAB. IV.



Lapiereux del. ugni sc.

Fig. 1. Diplotegium truncatum, Sp. nov.. Fig. 2. Lepidodendron diplotegioides, Sp. nov Fig. 3. Lepidophloios irregulare, Sp. nov.. Fig. 4. & 4a. Cardiocarpon ingens, Sp. nov.. Fig. 5. Cardiocarpon affine, Sp. nov.. Fig. 6. Carpolithes platimarginatus, Lsqx.. Fig. 7. & 7.a Calamites undulatus, Sternb..



Leo Lesquereux del. Dougal

Fig. 1. & 1.a Sphenopteris decipiens, Lsqx. Fig. 2. to 6. Neuropteris tenuifolia, Brgt. Fig. 7. Odontopteris intermedia, Sp. nov.. Fig. 8. & 8.a Rhabdocarpos minutus, Sp. nov.. Fig. 9. Rhizolithes palmatifidus, Sp. nov.. Fig. 10. & 10.a Dyctiopteris obliqua? Bunb.. Fig. 11. Blattina venusta, Sp. nov.. Fig. 12. Wing of Blatta Maderae, Fabr..

resembles *Neuropteris flexuoso*, Brgt., it is easily distinguished by the more generally rounded base of the leaflets. It is very variable in size, and sometimes the leaflets are expanded on one side and somewhat auriculated. The veinlets, though thin and generally divided two or three times, are more distinct than in *Neuropteris flexuosa.* The species is interesting with regard to its distribution, and it was worth figuring it here because the Arkansas specimens show for the first time two extreme sizes of the leaflets of that fern. Fig. 2 is a very large, and fig. 6 a very small form, which have not been published before. Moreover, at least in America, the species looks peculiar to the lowest coal. It was found in abundance at Shamokin, Pennsylvania, in connection with the lowest bed of coal, either just above the Conglomerate, or between two strata of that formation. In Europe, if there is identity in the species, it has been found as high as the New Red Sandstone. It was seen at all the openings of the coal of Arkansas.

19. *Odontopteris intermedia*, Sp. nov. (Pl. 5, fig. 7.) This species appears to be intermediate between *Odontopteris Brardii*, Brgt., and *Odontopteris crenulata* of the same author. It differs from the former by shorter leaflets united to the middle, and by the basilar inferior leaflet which does not differ in form from the other, and is separated from the last species by entire leaflets and a more straight nervation. In our species, the leaflets are somewhat obtuse; the medial nerve is marked sometimes, or entirely obsolete; the nervules are very thin and obsolete. Both primary and secondary rachis are broad and flat. Better specimens will be needed to fix the validity of this species which, in any case, has not been found till now in America, but at Jenny Lind prairie coal-bank.

20. *Rhabdocarpus minutus*, Sp. nov. (Pl. 5, fig. 8 and 8 *a*). A small fruit, of which the natural size, fig. 8, is enlarged, fig. 8 *a*. It is oval in outline, marked with a small notch at the base, and regularly and minutely ribbed. Found at James' fork of Poteau, and at Male's coal-bank.

21. *Rhizolithes palmatifidus*, Sp. nov. (Pl. 5, fig. 9). Evidently a root, perhaps the root of *Cordaites Borassifolia*, Ung.; this last species being found in great abundance in connection with this root at Frog bayou coal-bank. With this root there was at the same place a fine branch of a *Stigmaria*, with distant leaves, scars very small, irregularly placed, and more distant than in any other species of this genus. It might perhaps be referred to *Stigmaria irregularis*, Lesq., of the Pennsylvania Geological Report. Want of room prevents its being figured.

22. *Dyctiopteris obliqua?* Bunb. (Plate 5, fig. 10 and 10 *b*). This small leaflet, fig. 10, enlarged fig. 10 *b*, is referred with doubt to this species. It belongs evidently to a species of the genus *Dyctiopteris*. But the leaflet is too small and too regular to agree with the species. Nevertheless, as nothing more was found of this plant but the small leaflet, it is not sufficient to give characters to a new species. Found at James' Fork of Poteau.

23. *Blattina venusta*, Spec. nov. (Pl. 5, fig. 11.) It is one of the most interesting remains found in the coal formations of America. It shows the upper wing, partly broken, of an insect related to the genus *Blatta*, of of which our common cockroach (*Blatta Americana*) is a species. Prof. Germar has already figured and described in Germany some of these always very rare remains; but our species differs much from all those which have been found in the coal of Europe. The wing represented, fig. 12, belongs to the still living species, *Blatta Maderæ;* it is copied from the figure of M. Germar, and shows the greatest likeness to ours. Its nervules are also, though more remotely, marked by transverse reticulations. This fossil wing found in the shales of Frog bayou, has apparently its extremity broken out, and its general outline is likely the same as that of fig. 12. The presence, in the coal-measures, of insects of which the identical type has been preserved till our epoch, is a remarkable phenomenon of natural history, and could not be but carefully recorded.

SPECIES OF FOSSIL PLANTS FOUND AT DIFFERENT LOCALITIES IN THE SUBCONGLOMERATE COAL-BEDS OF ARKANSAS.

	Male's Coal-bank.	Lee Creek.	Frog Bayou.	Jenny Lind Prairie.	James' Fork of Poteau.
1. Alethopteris nervosa, Brgt., ...			"		"
2. Alethopteris Owenii, Sp. nov., . . .	"	"			"
3. Annularia sphenophylloides, Ung., . .				"	"
4. Asterophyllites equisetiformis, Sternb.,					"
5. Asterophyllites gracilis, Sp. nov., . .	"				
6. Blattina venusta, Sp. nov., ...			"		
7. Bornia ? Sp. nov., ...	"				
8. Calamites approximatus, Sternb., . .	"			"	"
9. Calamites cruciatus, Brgt., ...	"				"
10. Calamites undulatus, Sternb., . . .					"
11. Cardiocarpon affine, Sp. nov., . . .	"				
12. Cardiocarpon ingens, Sp. nov., . . .	"		"		
13. Carpolithes platimarginatus, Lsqx., .	"	"			
14. Cordaites borassifolia, Ung., ...	"		"		
15. Cyclopteris (broken specimen), . . .					"
16. Diplotegium truncatum, Sp. nov., . .	"				
17. Halonia pulchella, Sp. nov., ...	"				
18. Hymenophyllites flexicaulis, Sp. nov., .	"	"			
19. Hymenophyllites, Sp. nov.,*					"
20. Lepidodendron diplotegioides, Sp. nov.,			"		
21. Lepidodendron modulatum, Lsqx., . .	"		"		
22. Lepidodendron vestitum, Lsqx., . . .	"				"

* Specimens too small for close determination.

Fig. 1.

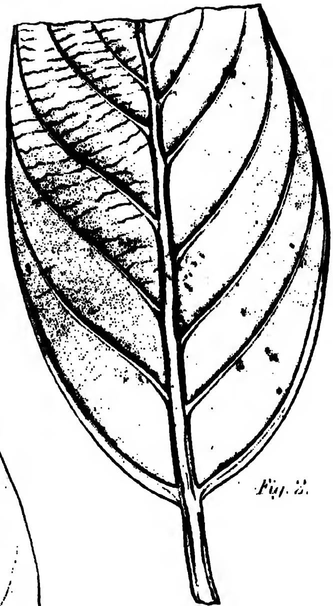


Fig. 2.

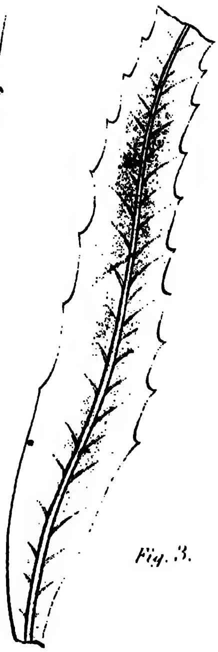


Fig. 3.

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Fig. 1. Magnolia Hilgardiana, Sp. nov.. Fig. 2. Rhamnus marginatus, Sp. nov
Fig. 3. Quercus Saffordii, Sp. nov..

	Male's Coal-bank.	Lee Creek.	Frog Bayou.	Jenny Lind Prairie.	James' Fork of Poteau.
23. Lepidophloios irregulare, sp. nov., . .	"				"
24. Lepidophyllum brevifolium, Lsqx., . .			"		
25. Lepidophyllum lanceolatum, Brgt., . .		"			
26. Lepidophyllum, leaves of Lepidodendron, ...	"	"	"	"	"
27. Lepidophyllum majus, Brgt., ...	"	"			
28. Neuropteris fimbriata, Lsqx., . . .				"	
29. Neuropteris hirsuta, Lsqx., ...				"	"
30. Neuropteris tenuifolia, Brgt., ...	"	"	"	"	"
31. Neuropteris vermicularis, Lsqx., . .					"
32. Odontopteris intermedia, Sp. nov., . .				"	
33. Pecopteris villosa? Brgt., ...				"	"
34. Rhabdocarpos minutus, Sp. nov., . .	"				"
35. Rhizolithes palmatifida, Sp. nov., . .			"		"
36. Sigillaria reticulata, Sp. nov., . . .	"				
37. Sigillaria, Spec. nov., ...	"				"
38. Sphenophyllum bifurcatum, Sp. nov., .	"		"		"
39. Sphenophyllum longifolium, Gutb., . .					"
40. Sphenophyllum Schlotheimii, St., . .				"	"
41. Sphenopteris dilatata, Sp. nov, . . .	"				
42. Sphenopteris decipiens, Lsqx., . . .				"	"
43. Sphenopteris Gutbieriana, Germ., . .					"
44. Sphenopteris obtusiloba, Brgt., . . .	"	"	"	"	
45. Staphyllopteris stellata, Sp. nov., . .	"				
46. Stigmaria ficoides, Brgt., ...	"				
47. Stigmaria irregularis, Lsqx., ...			"		"
48. Stigmatocanna?	"				

From a view of this table, the following conclusions can be drawn. That of forty-eight enumerated species, eighteen are new, and consequently have not been found above the Millstone Grit. Two more, represented by broken specimens, are perhaps new also, and thus 26 to 28 species of the Arkansas coal have been found before in strata of coal above the Conglomerate formation, at other places in the United States coal-fields. I doubt not that if we had had a whole day to spend at Male's coal-bank instead of an hour, we would, with the assistance of Mr. Cox, have collected at least a dozen other new species. But the number of old and already known species would have been greater also, since in a hurried examination I could note only the most marked species which were seen. Therefore the coal plants of the Male's bank may be considered as presenting in a fair average the proportion of old and new species of plants pertaining to the coal-beds below the Millstone Grit. Admitting this, I do not think that this proportion of new species of plants of the Arkansas coal-measures authorizes a separation of these measures from the beds above the Conglomerate; permitting the dis-

tinction of another name (that of *false coal-measures*), as if they were a peculiar formation. The proportion of large species and fossil trees appears to be greater in Arkansas. But the same proportion continues, though in decreasing order, till we reach coal No. 1 A and coal No. 1 B above the Millstone Grit. And certainly the difference in the species between these last strata and coal No. 4 placed at the base of the Mahoning Sandstone, at a distance of about 250 feet, more or less, would appear far greater than between the Subconglomerate coal of Arkansas and coal No. 1 B.

New discoveries of fossil plants by the Geological State Survey of Illinois show the proportion of large trees increasing as far down as below the Upper Archimedes Limestone, where a thin bed of coal is sometimes present, as at Fayetteville. Nevertheless, the plants of this low position are still of the same genera as those of the true Coal-measures, and half of them, at least, have the same specific characters. Thus, it is evident that the true Coal-measures descend as low as the Subcarboniferous Limestone and even can be counted to the second bed of the Archimedes Limestone. Not much coal is formed there, it is true, but it is the beginning, the infancy of the epoch, which, as at the time of its decrepitude and near its end, has the strata of combustible matter scarcely formed and thin.

It is impossible now to establish a close comparison between the strata of the Old Red Sandstone of Pennsylvania and the Subcarboniferous Limestone of the West, which, following the assertion of some geologists, occupy its place. From some data formerly collected, the Red Sandstone of Pennsylvania had very few species, if any, identical with those of the Coal-measures. It is characterized especially by the species of true *Noeggerathia* which have never been found in connection with the coal, and which I have found in abundance in the red shales immediately underlying the conglomerate formations of Mauch Chunk and Pottsville, and lower still.

It would be even more difficult to compare the distribution of the plants of the Coal-measures and of the New Red Sandstone or Permian overlying them. The Permian is scarcely known in America, and no plants have been found in it. But in Europe, the proportion of the vegetable species common to the Permian and the Coal-measures is no more than eight per cent, while between the Subconglomerate coal and the Coal-measures above the Conglomerate, the proportion of common species is from fifty to fifty-five. Moreover, with the appearance of the Permian, a number of entirely different typical forms, mostly Coniferæ (Araucarites, Walchia, Pinites, &c.), appear at once; and these forms having no relation whatever to the genera of plants of the coal-measures indicate a new epoch in the vegetation. Thus it is certain, that if we should separate, as some geologists have done, the Subconglomerate coal as a peculiar formation, we would do it against the general laws of distribution of the species and

would be forced to consider each peculiar bed of coal as a separate formation or rather as an epoch.

The other conclusions taken from the examination of the table are in favor of the horizontal identity of all the coal strata of Arkansas, the apparent difference in their species resulting from the small number of fossil plants which have been found at some localities. Thus the coal of James' Fork of Poteau where, after Male's coal-bank, the largest number of fossil plants were seen, has, in twenty-five species, ten species in common with Male's coal, some of which are new and apparently truly characteristic of the subconglomeratic coal. Of ten species collected at Jenny Lind coal-bank, eight were seen also at the James' Fork of Poteau. Seven of the eight species of Lee creek coal have been found also at Male's, and of eleven fossil plants found in the shales at Frog Bayou, seven belong also to Male's coal-bank. Taking into consideration the insufficiency of the researches and the distance of the coal-banks where the plants were found, it is easily admitted that this approximate identity of species shows with great probability, if not with certainty, that the coal-banks or strata reported above are to be placed on the same geological horizon.

LIGNITES OF ARKANSAS, AND FOSSIL PLANTS OF THE SAME FORMATION.

The Lignite formation is easily distinguished from the Coal-measures, as well by its distribution, its geological position, the chemical compounds of its combustible matter, as by the plants by which it is accompanied. From the few data which have been collected in Arkansas it appears that the lignites of that State are found generally near the base of the Tertiary measures.* They have been formed by an accidental deposition of a certain quantity of wood, apparently transported by rivers or some other agency, or even perhaps are composed of the heaped remains of trees which grew in marshes and swamps at the place where beds of lignites are now found. The areas which they cover with strata of combustible matter is extremely variable. Sometimes they extend themselves for hundreds of miles, preserving a constant horizon ; sometimes they have only a few feet in diameter, and appear either thin or like a broken and heaped compound of combustible black matter, irregularly placed at various horizons in the same vicinity. Beds of Lignites are generally intermixed with clay or sand. Their overlying strata are not shales, but mostly soft, black or yellow plastic clay or sand. The numerous remains of plants found in this soft matter are of course decayed, broken, and undistinguishable.

The only bed of Lignites which I had an opportunity of examining in

* See Sections in the Report of the State Geologist.

Arkansas, is exposed on Little Cypress Creek, Dallas county, on the property of Mr. Watson. It crops out on the nearly perpendicular and much disturbed bank of the creek, is one to two feet thick, sometimes black and a compound of pure combustible matter much softer than stone coal or true coal, sometimes formed of alternate layers of soft clay with bands of black and pure lignite, from one to two inches thick. There are apparently two beds of lignite exposed on this bank. The one, nearly at the top of the bank, is overlaid by one foot of black soft clay covered with about twenty feet of argillaceous sand. The other exposed a little lower down the creek appears separated from the former by nine feet of soft plastic clay without plants. As the bank has been much disturbed by the erosions of its soft parts, which have caused slips and local subsidences, it is still possible that there is only one bed of lignite formed there, parts of which have accidentally been broken off and dropped down the declivity of the bank.

In counties where wood is still abundant, beds of tertiary lignites are perhaps, for the present, of no great value. Nevertheless, when the combustible mineral is pure, the amount of carbon which the matter contains is always greater than it is in wood. Following the analysis of two specimens of lignite of Green county,* the amount of carbon in the matter is fifty-three to fifty-seven per cent., when the carbon of wood does not amount to more than forty to forty-five per cent. Thus, these beds of lignites may become valuable in the future, especially for the navigation of the steamboats on the rivers.

As beds of lignite, found in the southeastern part of Arkansas have been taken sometimes for strata of true mineral coal by persons unacquainted with the distribution of the geological formation, it is well to present in a single table, and for comparison, some of the fossil leaves which are generally found in connection with these beds of recent origin. All the leaves found fossil in the Tertiary, recall forms which we are in the habit of seeing around us on the trees of our time. Most of the genera, even some of the species are the same. Thus we have with the lignitic formation, fossil leaves of the oaks, walnuts, beeches, magnolias, elms, and others; mostly leaves of Dicotyledonous trees, easily recognized by the branching of the veins. On the other hand, the fossil leaves of the true coal are mostly ferns, and the other remains represent the scars on the striæ of the bark of trees of which the form, the direction and the remarkable regularity is entirely at variance with the rough and irregular surface of the bark of our trees. (See Pl. 3, fig. 1, 2, and 3.)

The leaves figured on Plate VI were not found in the tertiary strata of Arkansas. The time of exploration was too short to permit researches

* 1st volume of the Report, p. 177.

for fossil leaves, which could be found only by opening the clay-banks overlying the lignites. But they were taken from the chalk-banks of the Mississippi and from the red shales of Tennessee, of which the position is apparently a little superior to the place generally occupied by the beds of lignite and certainly of the same age.

DESCRIPTION OF FOSSIL LEAVES OF THE TERTIARY.

1. *Magnolia Hilgardiana*, Sp. nov. (Pl. 6, fig. 1). Apparently a leaf of a new species of the beautiful genus *Magnolia.* It has a great likeness to *Magnolia tripetala*, Michx. (the umbrella-tree), but is rounded and not pointed at its base. The nerves marked on the figure are a little broader than on the specimen. The primary and secondary nerves are strong and distinct, much curved upwards near the margin of the leaves. The tertiary veinlets are obsolete, at least on the specimens figured here, but from other specimens appear nearly straight and perpendicular to the secondary veins. The margin of the leaves and their surface is undulated. The specimens were communicated by Prof. Eug. W. Hilgard, to whom this species is dedicated.

2. *Rhamnus marginatus*, Sp. nov. (Pl. 6, fig. 2). This leaf, from various broken specimens of the same species, appears to have been generally oval-lanceolate, somewhat obtuse, and entire. The nervation is distinct. Primary and secondary nerves broad and thick, tertiary veinlets perpendicular to the secondary veins and about continuous. The secondary veins curving upwards and running up along the borders give to the leaf the appearance of being marginated. It is related to *Rhamnus Carolinianus* (Walt.), (the Carolina buckthorn), a common species in Arkansas. The fossil plant is found in the red shales of Tennessee and also, apparently at least, in the chalk-banks of Columbus, Kentucky.

3. *Quercus Saffordii*, Sp. nov. (Pl. 6, fig. 3). A very fine species of oak which, as far as I know, has no relation with any species now living on the continent of America. The leaves are nearly linear, from four to six inches long, taper pointed, with the margins cut by sharp, regular, distant teeth to near the base, where they are narrowed in a short petiole. The medial nerve is broad and flat; the secondary nerves are of two kinds; long and running to the points of the teeth; or intermediate to them and shorter. This species was found and communicated by Prof. James M. Safford, State Geologist of Tennessee, whose name it bears.

RECENT BOTANY AND GENERAL DISTRIBUTION

OF THE

PLANTS OF ARKANSAS.

GENERAL REMARKS.

The distribution of the plants of a country, according to the nature of its geological formations, is extremely difficult to settle with any chances of reliability. It has been asserted with apparent reason:

1st. That it is still uncertain if the chemical elements of the soil, even if it was proved that they are directly depending on the nature of the underlying geological strata, have a perceptible influence on the vegetation which naturally covers any peculiar place. That, in any case, the amount of influence which the chemical constitution of the soil exercises upon the distribution of the vegetation is still problematical.

2d. That the geological elements, viz., the particles resulting from the decomposition of the rocks and entering into the composition of the soil, even if their influence on the vegetation were well marked, are generally disseminated by water and atmospheric agency to a great distance from the areas occupied by the formations from which they come. The lime of a limestone ridge, the sand of a mountain of sandstone are carried down the declivities, spread over other kind of rocks, transported to the alluvial plains, or deposited on the banks of rivers and thus mixed together in a peculiar compound which, in its new state, has but an indirect relation to the rocks from which it is derived, and no relation whatever to the formations which it covers. Moreover, the frequent alternations of strata of sandstone and of limestone which compose the rocks of the great Valley of the Mississippi, Silurian, Devonian, Carboniferous, and Tertiary, prevent an exact limitation of the area over which each of them may extend its influence. Thus, it has been generally admitted that physical circumstances more actively govern the distribution of the vegetation of a

country than can chemical constituents of the rocks. Consequently, that the direction of the ridges, the amount of light and atmospheric heat and moisture, the thickness of the soil, its hardness and capacity for retaining water, are the essential causes of the distribution of the plants.

These considerations may be true, but they touch only one side of a complex and difficult question which cannot be discussed now. If the hardness, compactness of a soil, its capacity for retaining water and heat, are essential causes affecting the distribution of the plants, it is evident that this cause depends principally on the chemical nature of the geological strata. On the other hand, if the dissemination of the geological elements renders the task of ascertaining their influence difficult in some places, it is not a reason to reject as useless or impossible any attempt to compare the vegetation of a country with its geological formations. If this comparison can be made anywhere with a chance of success, it is certainly in Arkansas, where the strata are nearly horizontal and extend over vast areas.

The exploration of the Botany of Arkansas began too late and was too short to permit the fulfilling of a work which for its completion would require some years of continual research. The following data collected along our road of travel can thus be considered only as the first points of delineating lines which may be continued and completed hereafter.

MAMMOTH SPRING OF FULTON COUNTY.

The Mammoth Spring of Fulton County has been already described on page 60 of the first volume of this Report. Its water is almost entirely filled with aquatic plants covering its bed even to a great depth or floating on the surface. A phenomenon like this, in a spring of so wide an extent, is remarkable enough to merit an examination.

It is well known that plants absorb by the green surface of their leaves a certain amount of carbonic acid which serves them as food, and which they transform into carbon. Springs emerging from limestone rocks generally contain carbonic acid in small quantity and thus may nourish some plants in their water.

The water of the Mammoth Spring, either by compression or from some other peculiar cause, contains, apparently, in solution, such a great amount of carbonic acid that its surface is in a continuous state of effervescence or bubbling, resembling the effervescence of a fountain of soda water. Perhaps the phenomenon is caused by atmospheric air taken into the water by its running through beds of porous cherty limestone from which it emerges. This would not alter the conclusion, because atmospheric air

containing carbonic acid, has the same influence in promoting vegetation.

Whatever the cause may be, the bottom of the Mammoth Spring, at a depth of four to eight feet, under the clear water of the fountain, is covered with a carpet of moss of a species (*Hypnum noterophyllum*, Sull. & Lsqx.) which generally, and at other localities, grows on stones washed by only a few inches of running water. These mosses, torn in great bunches from the bottom, rising up to the surface and floating with the current, are stopped by the leaves and stems of large water-plants, to which they remain attached, and by continuous agglomeration of other mosses, or broken pieces of plants, they form on the surface of the water, wherever the current is not too strong, floating carpets of green turf, which become strong enough to sustain the vegetation of a few species of land plants. The species generally found with the mosses composing this floating turf are: the Horned Pond-weed (*Zannichellia palustris*, L.) which lives also under deep water, and is uprooted from the bottom; three species of Duck's meat, small round floating plants, which generally live on the surface of ponds, but which are here in an unparalleled abundance, with broken branches of all the other species which vegetate in the spring. The compactness of the floating carpet is still increased by small mollusca, especially by a small species with soft shell (*Physa ancillaria*, Say.) which lives there in immense numbers, feeding upon the decomposed pieces of broken plants. It is especially these mollusca with the Duck's meat which attract the water fowls, providing them with a delicate, never-failing and abundant food. The constant temperature of the water (60°) favors, apparently, the development of animal life, at least for the shells, and is another cause of allurement for the fowls, especially during the winter months.*

A number of other species of plants worth mentioning live in the Spring, attaching their roots to the bottom, and raising their long stems to the surface. Around the principal very deep and central basin of the fountain there are two species of Pond-weed (*Potamogeton natans* and *P. lucens*) with stems at least twelve feet long. Where the water is swifter-running, and not deeper than four to six feet, species of the Water Milfoil, another Pond-weed (*Potamogeton compressus*), the Water Persicaria, the American Brooklime, the Burr-reed, the Water-weed, the Water Starwort (two species) fill the water with the multitude of their long stems and branches. Near the borders, but still in water one foot deep at least, one finds the Marsh Speedwell, the Mint, introduced by the Indians? and growing with great luxuriance, the Spotted Touch-me-not, the Bur-

* It is a remarkable fact that no fishes are found in the spring above the dam. Is this phenomenon caused by the constant temperature of the water, or by the quantity of air or carbonic acid which it evolves?

Marigold, the Water-cress, probably also introduced, the Penny-wort, the Water-Parsnip, and some other species.*

Some of these plants, especially the Pond-weed (*Potamogeton compressus*, L.), the Water Persicaria, the American Brooklime, grow in the bed of Spring River, below the bed of the Mammoth Spring. The cattle of the vicinity greedily feed on them, and thrive finely, though spending whole days in water. The two last species of plants, when growing on wet soil, as they generally do, and under atmospheric influence, are somewhat bitter, hard, and scarcely touched by the cattle. Under water they are subjected, by deprivation of a full light, to a kind of chlorosis or etiolation, which renders them tender and nutritive. The Indian rice and the Rice cut-grass grow also below the dam along the muddy banks.

I truly regret that it does not come within my province to dwell on the natural beauty of the Mammoth Spring and of the hilly country surrounding it. The place will doubtless in the future acquire great importance as affording a healthy and pleasant place of summer resort.

PRAIRIES OF ARKANSAS.

Before entering into the examination of the botanical distribution characteristic of the part of Arkansas which I explored, there is still a peculiar question which cannot be easily treated elsewhere, and which calls at once for an examination.

The Prairies of Arkansas do not appear to have been formed all in the same manner. They are underlaid by different formations, situated at various elevations, and their general aspect differs apparently so much, that it looks as if a peculiar law had directed the formation of each of them.

I have explained elsewhere† the general formation of the prairies, and ascribed it to the agency of water. All the prairies still in a state of formation along the great lakes of the North are nothing else but marshes slowly passing to dry land by slow recession of water. When land is continually covered by low stagnant water, its only vegetation is that of the Rushes and of the Sedges. When the same land is alternately subjected to long inundations and then to dryness, during some months of the year, the same plants continue to cover it. By their decomposition these marshy plants produce a peculiar ground, either black, light, permeable when it is mixed with sand, as it is near the borders of the lakes, or hard, cold, impermeable when it is mixed with clay or muddy

* For Latin names and for other species of plants of the Mammoth Spring, see Catalogue of the Plants of Arkansas.

† Bulletin of the Society of Natural Sciences of Neuchatel (1856).

alluvium, as in some marshes underlaid by clay or shales, or along the banks of some rivers. Land continually covered with stagnant water cannot produce any trees, because the trees require for their growth, like most of the terrestrial plants, the introduction of atmospheric air to their roots. Neither do trees germinate and grow on a ground alternately covered with stagnant water and exposed to dryness for some months of the year. From these considerations, the law of the general formation of the prairies can be deduced: While a land or a part of a country is slowly passing from the state of swamp or marsh to the state of dry land the annual alternative of stagnant water and dryness causes the vegetation of peculiar plants, which, by their decomposition, form a peculiar soil unfavorable to the growth of the trees. From this general rule of formation, which regards only the prairies of the Mississippi valley,* all the different phenomena or peculiar appearances of the prairies can be easily explained.

The prairies of Arkansas, following their vegetation and their geological connection, may be separated into three classes:

1st. The prairies of the North, mostly underlaid by cherty limestone.

2d. The prairies of the West, on carboniferous shales and clay.

3d. The prairies of the South and East, overlying tertiary and alluvial formations.

1st. The limestone prairies of North Arkansas mostly belong to the counties which are examined in the next division. They are singular in this fact, that their surface is not always flat, and that they are mostly placed on soft declivities or coves along or between the ridges. They are mostly of small extent and surrounded by thickets of low trees. The compact or somewhat porous Subcarboniferous Limestone which they cover does not absorb water with rapidity. Hence, in the spring, water percolates slowly along the slopes, taking with it the detritus of the stone, and depositing it where its course is either stopped or slackened. A scant swamp vegetation springs up there, its decomposed remains are mixed with the original deposit, which, by and by, augments in thickness under the action of water and of vegetation. This soil is naturally spongy, preserves water for a part of the year, like the peat, which it resembles, and thus cannot sustain trees. They establish themselves on a firmer ground all around. When by successive contribution of limestone deposited by water and of particles of humus received from the plants this soil has become thick enough, it is, when drained by a few ditches (serving as channels for the water of the rainy season), a fertile and easily cultivated ground. The channels of drainage are generally formed by a natural depression, the depth of which varies with the thickness of the soil of each

* The prairies of the far West, along the eastern base of the Rocky Mountains, are true sandy deserts, caused by the dryness of the atmosphere.

prairie. In this case, as coarser materials are of course heaped on the banks of these creeks, a few trees grow along them. They are mostly stunted specimens of the Post-Oak, the Rock Chestnut Oak, the Persimmon, the Mockernut, the Juniper, and a shrub, *Bumelia lanuginosa*, Pers. The characteristic herbaceous plants of these limestone prairies are especially: *Ambrosia polystachya*, *Kuhnia Eupatorioides*, *Aster sericeus*, *Croton capitatum*, *Grindelia lanceolata*, *Palafoxia callosa*, *Oxibaphus albidus*, &c., species which are not found on the prairies of other formation. Besides these plants they are covered with a great number of species belonging to the prairies in general.

Between this and the second division of the prairies, viz., of those which are formed on the Carboniferous shales and clay, there is a remarkable transition, which unites both divisions, or rather shows their common origin. In the western parts of Benton and the northern part of Washington counties some flat prairies, formed like those of the second division, and underlaid by shales or red clay, have still at their surface some isolated patches of Subcarboniferous cherty limestone, which appear here and there, breaking the general horizontality like small mounds. Possibly these low mounds could support the vegetation of the trees, and they may have been transformed into prairies by the influence of fire, which is a secondary agent of their formation. But the soil which covers them is exactly of the same nature as the soil of the surrounding prairies, and as their height is no more than two or three feet, they may have been formed in the same manner and by the agency of water.

2d. The prairies on the Carboniferous shales are generally flat, surrounded by hills, or at least by a higher border, which gives them the appearance of the bottom of drained lakes. These prairies are of various extent, and although they may overlie different kinds of ground or geological formation, in Arkansas they are generally underlaid by Carboniferous fire-clay or shales. In the spring they are covered with water which cannot percolate, and become true marshes for a time, and have the vegetation of marshes: the rushes and the sedges. This semi-aquatic vegetation gives, according to the nature of the underlying strata, either a hard, compact, cold soil, by decomposition of shales or clay; or, when mixed with sand, the peaty black soil of the prairies of Illinois and of the Northern States. In the summer months, these marshy prairies become dry by evaporation, and as it happens with the prairies of the first section, the alternative of too much water and of dryness in the soil prevents the growth of trees.

These prairies are more sterile or rather more difficult to cultivate than those of the former section, as we shall have occasion to see when examining the counties of Sebastian, Franklin, &c., where this kind of prairie is mostly found. A few trees,—the Water Oak, the Pin Oak, the Honey

Locust,—grow along the creeks which meander in their middle. The soil is, in its natural state, mostly covered with the great Compositæ of the prairies and the hard grasses, species of Beard-grass and Broom-corn.

The prairies of the third class are extensively formed in Arkansas on the Tertiary or Alluvial land bordering some rivers of the South, especially Red River. Our exploration did not extend to that part of the State. It is very probable that these prairies have been formed in the same manner and by the same agency as those of the other sections. From the catalogue of Mr. Nuttall, who explored these plains, their plants appear somewhat different from those of the other prairies. They rather bear the character of a Western Flora, or of the Flora of the plains extending toward Mexico.

GEOLOGICAL NATURE OF THE SOIL AND VEGETATION IN FULTON, MARION, CARROLL, MADISON, AND BENTON COUNTIES.

The characteristic formations of all these counties are: the Silurian either cherty or compact limestone, with some strata of sandstone, and the Subcarboniferous cherty or compact limestone, with alternating beds of shales or of sandstone. The geographical character of the country is that of a plateau divided into a series of successive ridges by numerous clear creeks, mostly running southward or northward to White River, or by some of its forks. When these ridges are composed of compact, hard magnesian limestone, they are nearly barren, the top only being covered with a scanty vegetation. When the limestone is somewhat porous and retentive of water, the flat surfaces of the tops, or even the declivities of the ridges, are covered with prairies. Where the rock is soft and easily disaggregated it is mostly covered with trees.

In the eastern part of Fulton County, the ridges, mostly of cherty limestone, are rocky, but, nevertheless, covered with trees of small size: the Mockernut Hickory, the Black Jack and the Post Oak. The top of these ridges is clothed by a luxuriant vegetation of grasses and numerous species of herbaceous plants, thus furnishing a good and abundant pasture for cattle, especially for sheep. A great number of them could be raised in this country. The slopes are gentle and covered with humus, or with a soil of greater fertility than might be supposed from the stunted growth of the trees. It is the Hickory or Mulatto-barren soil, soft, permeable, of a grayish color, producing abundant crops of corn (fifty to sixty bushels to the acre in favorable situations), and especially wheat (twenty-five to thirty-five bushels an acre). The trees naturally growing on this kind of ground are scattered or distant, of the same species as those of the ridges, with the Red, the Black, and the White Oak. The Spanish Oak is also mixed with this vegetation, but it is scarce, and of the remarkable variety *Quercus*

tridentata, Engl. By the form of its leaves and the small size of the tree, this variety would appear as a true species, were it not that westward and in coming to the sandstone it is seen passing by and by into its normal form. The trees become larger, and the three-pointed leaves remain still upon the lowest branches of the tree, while higher up, the other leaves are cut into from four to six long narrow divisions. On the Hickory barrens the trees are generally of a small size, and the forests without underwood, —a phenomenon which may be caused either by the hardness of the rock, which cannot be easily penetrated by the roots, or by fire, which ought to be active on such a rocky light soil.

Between these low cherty ridges the flats or bottoms along the creeks are mostly half prairies, covered with Shrubs, Greenbriers, Indian Currant (in abundance), two species of Sumach, the Kinnikinnik, and the Sassafras. The soil is black, deep, somewhat cold, and clayey (a character showing the nature of its formation by water), and apparently less fertile than the soil of the slopes. It produces, on an average, forty to fifty bushels of corn, and is too compact, too strong for wheat. As these half prairies form the banks of streams, of which the beds are generally deeply cut, it would be easy to drain them, and thus they would be better for agricultural purposes than the upper Mulatto land, because they are formed of the same rocks, have the same elements, and have also a far greater nutritive power.

Between Salem and Benetz Bayou the Subcarboniferous Sandstone crops out and constitutes some hills. Its vegetation shows a difference first in the size of the trees, which become larger and of a more healthy growth. With the Mockernut, the Black Jack and the Post Oak in the most barren places this sandstone has the Chincapin or Dwarf Chestnut, which sometimes descends the declivities to the base of the hills; upon the gentle slopes the Black, the Red, the Scarlet, the White and the Spanish Oak (this last becoming of great size), and the Black Gum which does not like the limestone. The underwood is pretty thick in places, formed of Sumach, Hazel, and especially of the Fackleberry, also a species characteristic of the sandstone. Where the underwood is wanting, three or four species of Bush Clover, a beautiful Blue Gentian (*Gentiana puberula*), three species of Gerardia, some Asters, especially *Diplopappus linariifolius*, and the Dittany, all, except the last, showy and richly-colored flowers, clothe the rocky ground.

Though this sandstone is more favorable for the vegetation of trees than the cherty limestone, the agricultural value of the soil derived from it is far from being as great. The decomposed parts of the rocks, though pulverized and mixed with the decayed remains of plants, preserve their nature of *sand*. Sand being too permeable to water and too dry, the decayed plants scarcely arrive at a point of fermentation necessary to trans-

form them into humus. Thus this soil does not only want the fertilizing elements of the limestone, but the vegetable mould. The healthy growth of the trees on this kind of soil is easily explained by the softness and permeability of the rocks. The roots and rootlets penetrate them, and find humidity and food more easily than in the hard limestone.

The Alluvial formation derived from this sandstone has, like the soil of the ridges, a vegetation somewhat different from the alluvial or bottom land derived from limestone. The alluvial of sandstone has, contrary to that of the ridges, smaller trees than the alluvial of limestone. Its species, which grow close together, are the Birch, the Elm, the Pignut, the Post Oak, the White Oak, the Black Oak, the Chestnut, and the Spanish Oak. On the bottoms derived from limestone, we find especially the Linden, the Buttonwood, the Silver Maple, the Ash-leaved Maple, the Ash, the Honey-Locust, and in the most fertile places the Overcup Oak. The Black, the Red, and the White Oak belong also to this alluvial ground, where they take sometimes an enormous size.

Many species of Oaks and of Hickory are distributed nearly on every kind of soil, as the White, Red, Black Oaks, with the Black Jack and the Post-Oak, and also appear at far different situations. The Black Jack and the Post-Oak are seen upon the barren rocky ridges, whether sandstone or limestone; upon barren declivities, clay, swampy ground, generally showing sterility. The White, Red, and Black Oaks, especially, cover the slopes also on both formations, descend to the bottoms, more or less indicating the value of the soil by the luxuriancy of their size and the development of their branches. Nevertheless, we have seen that they thrive well on sandstone, though the soil may be poor for agriculture. It is sometimes very difficult to ascertain the geological nature of an alluvial soil. It may pertain to a limestone formation, though it is mixed with sand; it is the amount of lime dissolved in the water which essentially influences the natural distribution of the plants.

From Benetz Bayou, the limestone and chert are the predominant formations all along our road to the western limits of Carroll County. Thus the bottom land of Benetz Bayou appears very fertile. The Overcup Oak grows on this land. It is a species which we see here in Arkansas for the first time, and which is never found but on fertile alluvial soil. Corn especially, sugar, tobacco, and some little cotton, are cultivated, and grow finely in this part of Benton County, which, like the greatest part of Washington County, appears truly favorable for agriculture. If water could be found near the ridges the land would be far more settled than it is now. It is said that even on the rocky and most barren ridges water is generally found in subterranean springs by boring thirty to forty feet deep. I had no opportunity of ascertaining the truth of this assertion.

The great abundance of grape vines growing in this part of the country,

and the number of species of this genus belonging to Arkansas, the rocky and nevertheless fertile and warm soil of the so-called *Limestone barrens* of Fulton, Carroll, Marion, and other counties, permit the inference that the culture of the grape would be most successful in these counties.* Nevertheless, I have not seen a single grape vine around the farm-buildings. Do the planters consider the grape as a useless accessory to their more substantial food? As a diet, grapes belong to the most wholesome fruits, especially in a warm country, and just at the season when they are ripening. In the hot season of the fall, they do for the body what the bitter sap of the Dandelion, the Cress, and other weeds may do in the spring. They purify the blood and the whole system by their antibilious, febrifuge, and scorbutic properties, and fortify it against the influences of the coming winter. It is a custom for sickly and feeble people of some countries of Southern Europe to go to a grape cure, as we go here to a water-cure establishment. For two or three weeks they eat nothing but full ripe grapes in abundance. Most beneficial results are obtained from this usage. Planting grapes upon the limestone of the counties of North Arkansas would thus at once improve the health of every family, and prepare for the future a more extensive culture for wine-making. Such a culture has become the most remunerative of all on the limestone hills of the Ohio River, which, by the geological nature of the soil, resemble the hills of Arkansas, but of which the climatic situation is far less favorable.

From the top of the Limestone Cliffs of the North Fork of White River, in Fulton County, the view from the hills on both sides of the river is truly beautiful. The country all around looks like an undulating sea of green forests, alternating with small prairies which appear like clearings, or patches of cultivated fields. These high limestone prairies or barrens are now becoming more extensive and more fertile. After passing the North Fork and some woody rocky ridges of cherty limestone we came to the Rap and Talbot barrens, on the eastern boundaries of Marion County.† A part of these barrens are well cultivated, and were, at the time we passed them, covered with fields of corn. Where the soil is thick enough it produces annually forty to fifty bushels of corn an acre, and is good for tobacco. It is about the same kind of soil as that of the half prairies of eastern Fulton. It is also too strong for wheat, and would require to be drained, or at least deeply ploughed, to show its full value. Naturally

* I have seen, in Fulton County, the Muscatine Grape growing finely in the middle of dry rocky beds of the torrents, and also on ridges covered with broken pieces of rock, where no other trace of vegetation was seen.

† See Geology of Marion County, 1st volume of this Report, pages 45 and 224. The difference in the vegetation of the Silurian and of the Subcarboniferous cherty limestone is not appreciable. At least I could not remark any. It may be that a more detailed exploration would permit us to ascertain some species peculiar to each formation.

irrigated every year by water running from the ridges of soft porous limestone, they are continually furnished with the nutritive elements of a rich soil. But even from the richest soil planters cannot expect a full harvest when they are satisfied with scratching the surface a few inches deep before planting their corn and tobacco. The stronger a ground is the deeper it ought to be ploughed.

It would be useless to mention again the names of all the species of plants naturally growing on these prairies, and characteristic of their soil. The catalogue gives sufficient indications of all. In the autumnal months their vegetation becomes remarkably rich in splendid forms and colors. The Compositæ especially, Button-snake Roots, Throughworts, Asters, Golden-rods, Sunflowers, Rosin-plants, with Indian Plantains, Rattlesnake Roots, Hoary Peas, Bush Clover, Gentians, &c. &c., render them as attractive to the eyes as well-cultivated flower gardens would be.

The bottoms of the North and of the Middle Fork of White River are, at the point where we crossed them, narrow but fertile, judging at least from the trees which cover them,—large Buttonwood, Honey Locust, Overcup Oak, and others. The bottoms of Crooked Creek, in Marion County, are also fertile and finely cultivated, like those of Benetz Bayou, producing corn, sugar, tobacco, and cotton. The limestone ridges are also as productive as in Fulton County, and are cultivated whenever they are not too rocky, and especially where they have some water.

In the central part of Marion County, magnesian limestone crops out, and forms higher, more abrupt, and entirely barren ridges. Trees are scarce there. Only a few stunted specimens of the Rock-chestnut Oak, the Juniper, the Persimmon, the Winged Elm, grow in the cracks of humid, decomposing rocks. Some species of herbaceous plants, the Ragweed (*Ambrosia polystachya*), the flocculent and whitish *Croton capitatum*, the pretty *Stenosyphon virgatum*, and the hard and long Beard Grasses, help to cover the barrenness of this formation. These ridges produce nothing. The patches of thin yellow soil, which are here and there attached to places where the water cannot attain them and carry them away, look like half-burnt pieces of brick, which can scarcely be attacked by any kind of vegetation. On the way from Yellville to Carrollton the alternation of high, steep, and sterile hills of the Magnesian Limestone, with low, undulating ridges of fertile Cherty Limestone, shows a remarkable contrast in the vegetation, and consequently in the fertility of both formations. On the same road, the sandstone is also exposed in some places, with the same characteristic vegetation that we have mentioned before. The highest ridges of Marion County are overlaid by Subcarboniferous Sandstone, and sometimes covered with Pines.

Entering Carroll County, we went somewhat out of our direction to visit the Huzza Prairie, which is reported as one of the most fertile parts of the

county. It is underlaid by the Subcarboniferous Limestone, has a deep, grayish soil, which resembles the black mould of some marshes, mixed with a subsoil of loam or argillaceous earth. The fertility of this prairie is due to the great thickness of the soil, to its natural drainage, facilitated by declivities, and perhaps also to a careful culture. The prairie being now nearly all cultivated, and the plants growing on the still unfenced parts of this prairie having been all cut to the root by the browsing of the cattle, I could not observe whether there were any peculiar plants, which could be accepted as characteristic of this soil. But I believe that the original vegetation was just the same as that of the limestone *fertile barrens* of Marion and Fulton counties. Some shrubs, the Sumach, the Persimmon, and the brambles, with the Blue Sage and the Horse Mint, are the only species which could be recognized.

The close browsing of the plants of the prairies around all the farms cultivated, show that these plants, except the too hard grasses and some Compositæ, are pretty good for grazing. From what I have seen of these natural meadows, it is even evident that, when the ground is not too wet, the species of grasses and other plants, like the Clover cultivated for hay, invade the natural prairies, destroying some of the worst grasses, and thus render them ultimately nearly as good for grazing as artificial meadows could be. The manure of cattle has a powerful influence in promoting this transformation. Thus it is most probable that the spreading of liquid manure over the prairies would, after a time, kill the hardest and most useless species of weeds, to let more delicate ones take their place. Another reason why the prairies are invaded by very hard grasses and by coarse plants of the family of the Compositæ is the annual burning of the surface. This process apparently facilitates the growing of spring grass, but it kills the delicate species, which are the best food for cattle. It is the strong, hard, silicious weeds, those which have thick roots, or roots trailing underground or deeply penetrating it, which are left from year to year, and invade the whole space. Salt alone has the property of killing some of the large roots of the Compositæ. Liquid manure contains a good proportion of it; but, generally, in well-managed farms, the active property of this manure is increased by the addition of salt, a small expense, which is repaid tenfold by the excellence of the grass and the richness of the crops.

The formation of the prairies is beautifully exemplified in the woods surrounding Huzza Prairie. This wood, being thick enough (mostly species of oaks and hickory, with an underwood of Sumach, Dogwood, &c.), has here and there round spaces of twenty to one hundred feet in diameter entirely deprived of trees and covered only by the plants of the prairies. In carefully examining these naked places, I always found them to be a little lower than the surrounding forest. They are certainly marshy, and covered with water in the spring.

The prairies of Carrollton County, though reputed as being more fertile than those of Marion and Fulton counties, have nearly the same average produce. When the season is dry, they give no more than thirty-five bushels of corn per acre; in favorable seasons, fifty to sixty bushels. Fifteen bushels of wheat is said to be the average. All the prairies of which the soil is not too compact and clayey, give good crops of oats. Last year (1859), oats were ruined everywhere except on the prairies.

The ridge dividing Crooked Creek from Long Creek is formed of Subcarboniferous Sandstone. As this sandstone is not cut by any banks of limestone, it afforded me a good opportunity of noting the species of plants pertaining to this formation, and which were not found on the limestone. The number of these species is not great, and they have been marked already. It is especially the Chincapin, the Black Gum, and the Spanish Oak, for the trees, with a greater abundance of the Black Oak, the Scarlet Oak, and the Mockernut. For the shrubs: the Fackleberry, and the species of herbaceous plants enumerated, page 62.

Long Creek has fertile bottoms,—a soil resulting from the decomposition of sandstone, chert, and limestone rocks, alternately exposed along its banks.* It is covered with species of trees characteristic of both limestone and sandstone formations. Thus it has the Black Gum, the Sweet Gum, which I saw there for the first time in Arkansas, and which becomes very common in the sandy bottoms of the south of Arkansas, the Overcup Oak, the Chestnut, the Red, the White, and the Spanish Oaks, the Mockernut, the Elm, &c. The Papaw and the Elder make here also their first appearance, becoming common further south. This land produces, on an average, sixty bushels of corn to the acre, or twenty bushels of wheat. It is not good for oats, but excellent for hay. It is rather light and permeable—a quality which it owes to the detritus of sandstone.

From Long Creek to King's River, along the Bentonville Road, there is a succession of low hills, formed of alternate strata of cherty limestone and of sandstone, which are generally cultivated, except on some of the most rocky and dry places. The highest ridges are still covered with beautiful prairies of the same nature, same fertility, and with the same vegetation as the Huzza Prairie. With the shrubs before mentioned, I find here the bristly Rose Acacia, forming with the Sumach dense thickets, which vary pleasantly the monotony of these plains. It is difficult to account for the difference in the amount of produce between these and the Huzza Prairie. From the reports received, they give, on an average, about thirty-five bushels of corn, or twenty of wheat, per acre. This difference is most probably due to the thinness of the fertile soil in some parts of the prairies of

* Near Carrollton, on one side of the creek, the bank, at its base, is formed of chert, in the middle of hard, compact limestone, and of chert again at the top. On the other side, the base is chert, and the upper part is conglomerate sandstone.

western Carroll County; the woods which border them are entirely rocky, or the ground is nearly a naked chert. This thinness of the ground is unfavorable to the growth of corn, which demands a deep soil, but cannot prevent an abundant growth of grasses or a good crop of hay. Artificial meadows, on these prairies, are very fine.

From Osage Creek to King's River, across a high divide, partly of sandstone, partly of Subcarboniferous cherty limestone, then from King's River up Keel Creek to the head waters of the War Eagle in Madison County, the general appearance of the country is the same as before, and the vegetation does not show any material change. The ridges are barren and dry, when they are high, steep, and narrow; but they are fertile and generally cultivated, when they are low with gentle slopes, and thus keep on their summit or their declivities the decomposed particles of limestone, which, on steep and narrow ridges, are easily washed down by the rain.

The bottoms of Keel Creek, though not cultivated, have a luxuriant vegetation of the species of trees indicating a fertile soil. Even the Papaw grows there, with the Overcup Oak, and, strange to say, with some Pines and Junipers. These last species of trees are brought with the torrents from the top of the highest hills, and become inhabitants of a bottom land contrary to their natural habitation. The declivities along this creek, though steep and rocky, are covered with a great abundance of herbaceous plants, and would furnish good pasture for sheep.

I have already alluded to the fertility of the soil formed from decomposition of Subcarboniferous chert. On the head water of the War Eagle, or of one of its branches, the half-naked, cherty hills have a scant vegetation of Post and Black Jack Oaks, with the Hazel and Ironweed. The ground is so rocky that the soil is hardly seen, except in some coves or depressions. Nevertheless, there are fine and large farms on this kind of ground, and, from inquiries, we heard that the average produce is nearly as good as on the prairies of Fulton and Marion counties. When the season is not too dry, it gives about forty bushels of corn per acre. Wheat is of course an uncertain production on such a rocky soil, but proprietors have raised twenty bushels of it per acre.

In the bottoms of the War Eagle, which are fertile and finely cultivated, I saw, for the first time in Arkansas, the Laurel or Shingle Oak, which, like other species that are very rare in the North, become abundant in the alluvial bottoms of the creeks near the Arkansas River. From here, also, the Pines, which until now were seen on the top of the highest ridges of sandstone, become more abundant, and descend even to the banks and bottoms of the creeks. With the Chestnut, they even appear now on the ridges of cherty limestone, affording apparently a proof of what has been said before; that the compactness of a formation or of a ground influences the distribution of some species, even of those that appear truly

characteristic, more than the chemical nature of the stone. This may be true for a number of species, and is easy to explain; for such trees, like the Pines, receive their food and moisture from the humidity of the atmosphere, and thrive on every soil, provided it is strong enough to fix their roots, and porous enough to give access to atmospheric air. But even among the species of trees there are some of which the distribution cannot be explained in this manner. Thus, the Juniper is peculiar to the limestone, and vegetates as well upon the naked rock as in the loose, alluvial, or dry soil of the hills, when they are derived from limestone. A number of herbaceous plants have, still more than the trees, this disposition to follow a peculiar formation, rather than be ruled in their distribution by purely physical laws. Even considering such species as the Pine, it is not certain at all that secret and purely geological influences have no action in their distribution, although we see them growing upon two as different formations as the cherty limestone and the sandstone. If the amount of silex of the sandstone favors their growth, this chemical principle is still more predominant in the chert. If the Pines follow the ridges all along the Arkansas River, and in Pulaski County cover by themselves hills entirely formed of quartz, we can see there that this quartz is either a metamorphic sandstone, or a peculiar substance which has taken the place of the sandstone, keeping still in its fissures a good deal of the remains or pieces of the original stone. Thus the Pines, though growing there apparently upon the quartz, can still spread their rootlets in its numerous fissures, where fragments of sandstone are still remaining. Moreover, chemically considered, quartz does not differ from flint or chert, and sandstone is mostly a compound of quartz.

The divide between War Eagle and White River is high, steep, and formed of a cherty limestone so porous that it resembles pumice. This rock is of course barren and uncultivated, being entirely deprived of water by percolation. It is covered by the Yellow Pine, the Chincapin, and the Chestnut, the Rock Chestnut Oak, the Black Jack, and the Post Oak, with some of the hardest species of herbaceous plants of the prairies.

From White River, after passing a rocky divide, the road ascends to a high plateau, covered with the far-extended and beautiful prairies of the Osages. They still overlay the cherty Subcarboniferous limestone; in some parts apparently the sandstone; and have the same nature and the same soil as the other prairies of this section. They are flat and of wide extent, and the lowest parts of the surface are marshy and somewhat difficult to drain. In the spring the low grounds are covered by three feet of water. Where the drainage has been attended to, the prairie soil produces, on an average, forty bushels of corn, or fifteen to twenty bushels of wheat an acre, or one thousand to fifteen hundred pounds of tobacco. It gives also fine crops of oats and of hay.

Benton, the county seat, is beautifully situated in the middle of these fertile prairies. From this place, or rather from the western borders of the prairies to the western limits of Arkansas, the country is still the plateau of limestone, broken by numerous creeks, forming narrow valleys or hills, covered with woods and a fertile soil. The vegetation appears to be the same as that of the hills of Fulton, Marion, &c. But it is well to remark here, that the frost has now killed all the herbaceous plants of the prairies, and that henceforth, in our journey, the botanical observations can be pursued but with great disadvantage, and derived only from dry leaves still attached to the trees, or mostly covering the ground.

GEOLOGICAL NATURE OF THE SOIL AND VEGETATION IN WASHINGTON, CRAWFORD, SEBASTIAN, FRANKLIN, AND JOHNSON COUNTIES.

The true Carboniferous Measures, that is, the sandstone and the shales of the Millstone Grit, with the clay and shales underlying it, are the geological strata from which the elements of the arable soil of these counties is mostly derived. The absence of limestone in the ridges, and the clayey nature of the strata, is at once perceptible in the whitish color of the water of all the creeks which spring from them. In all these counties, the hills or ridges are formed by the Millstone Grit, and consequently their summits are sandy, dry, and sterile, except on somewhat extensive plateaux where water does not find an easy course down the declivities and is retained, moistening the ground by percolating through it. On these flat surfaces only, the soil of the Millstone Grit becomes of sufficient thickness to be arable, and by cultivation is fertile enough. The characteristic trees of this ground are the Yellow Pine, the Spanish Oak, the Black Jack, and Post-Oak, the White, Black, and Red Oaks, the Mockernut, the Chestnut, and the Chincapin, with the Rock Chestnut Oak, the Persimmon, and generally the species of trees and plants which have been mentioned as characteristic of the Subcarboniferous Sandstone.

Near the base of the Millstone Grit, we find thick beds of red shales, covered by flaggy sandstone, and underlaid by beds of clay and black shales, containing sometimes one or two beds of coal. The land extending over these shales is, when flat, transformed into prairies. But, on all the declivities, or where it is cut in hills or undulations by the water-courses, it is covered with a fine growth of trees, viz., the Red, the Scarlet, and the Black Oak, the Yellow Chestnut Oak, the Laurel Oak, the Sweet Gum, Black Gum, Wild Black Cherry, Shellbark Hickory, and other species, some of which have not been found in the upper country, and with the limestone. The red shales form, by their decomposition, what is called the Red-upland, and is considered the most fertile soil of this division. As this

shale is soft, easily penetrated by the roots of the trees, and easily decomposed by atmospheric action, it makes an excellent ground for the growth of the trees, and consequently for the culture of fruit trees. While the north counties of Arkansas scarcely cultivate any fruit, in these western counties nearly every plantation on the red-upland is surrounded by a fine orchard of peach and apple trees.

Most of the too extensive flat lands of this division are prairies, which, underlaid as they are by impermeable beds of shales or of fine clay, are generally marshy. Their soil is too strong, hard, cold, acid, and scarcely cultivated. In Washington County only some of these prairies underlaid by red shales have a soil more permeable to water, and are partly cultivated. South of the Arkansas River, they are used only as natural meadows for cattle raising, and some of them pass to bottom-flats, characterized by some trees,—the Water Oak, the Willow Oak, the Pin Oak, and still the Post-Oak, all species which, except the last, are found also on the deep, fertile bottoms of the rivers.

Around Fayetteville, Washington County, the prairies show the peculiar character of a complex formation, that has been already mentioned, page 57, and described by the Principal Geologist in the first volume of the Report, page 112. The vegetation, as well as can be distinguished now, is nearly the same as that of the high prairies, and still shows the influence of the limestone. The shrubs are the Sumachs, the Hawthorns, the Brambles, and the Winged Elm. Some of the coarsest species of the prairie plants—the Ragweed, the Ironweed, the Basil, the Boneset—grows there in abundance. Part of these prairies are in cultivation. But the best land around Fayetteville is the red-upland, particularly good for the culture of cotton. It gives also fine crops of corn and of wheat; but it is not so good for tobacco.

Around Fayetteville and south of Washington County, through Crawford County to the Arkansas River, the hills are high, steep, and all of Millstone Grit formation. Where the top is flat, or at least unbroken, it is generally cultivated. The soil of the Millstone Grit, though it has no limestone, is richer than could be supposed from the porosity of the sandstone. It is light, sandy, permeable, and produces from twenty-five to thirty bushels of corn, or fifteen to twenty bushels of wheat per acre. It is still better for tobacco, giving, on an average, one thousand pounds per acre.* This soil is soon exhausted, and should be carefully manured. In dry seasons the crop is very short. Good springs are found at the top of the Millstone Grit, even on hills of small extent; but, generally, water is scarce in summer.

* These data were taken at the top of hills five hundred and fifty feet above Mill Creek, a branch of the Middle Fork of White River.

From the banks of White River, where the Shellbark Hickory, the Sweet Gum, the Maple, with the Red, Scarlet, Black, and Spanish Oaks abound, the divide, to the high waters of Lee's Creek, is still a broad ridge of the same formation, nearly six hundred feet above White River. This ridge has some farms on its top. It supports a very luxuriant growth of timber. The trees grow here at an equal distance from each other, just as though they had been planted by hand, raising their straight, large trunks to a height of sixty to eighty feet, and supporting immense pyramids of branches, forming thus an arch of plashing boughs. They are of the same species formerly enumerated, with the addition of the thick Shellbark Hickory, and without any underwood but some shrubs of the Chincapin.

There is also, in some barren places, a shrub much resembling the White Locust. The leaves are of the same form exactly, but the species appears only in tufts of branches growing up from the ground without a trunk. Perhaps this peculiarity is due to the action of the fire destroying the plant every year, and thus forcing it to grow shrubby.

The banks or bottoms of the water-courses, running between these high hills of Millstone Grit, are generally narrower than those which cross the subcarboniferous cherty formations. They are consequently rocky, and do not afford as large fertile plains for agriculture. Nevertheless, clearings and plantations are seen along Lee Creek and other creeks of the northern part of Crawford County.

In the southern part of this county the land becomes flat and the soil more sandy. It is arable, but of middle quality, especially characterized by the Spanish Oak, which there forms by itself whole forests. Between Van Buren and Frog Bayou there are extensive, somewhat marshy, sandy, and argillaceous flats, where this oak constitutes nearly the whole vegetation. Small prairies, apparently barren, enclosed in this forest, are surrounded by a beautiful Hawthorn (*Cratægus spathulatus*), now covered with fruits, and resembling branches of coral. Where the soil is more fertile or less sandy, the Sweet Gum and the Swamp Chestnut Oak replace the Spanish Oak, or are mixed with it. On the banks of the Arkansas River, near Van Buren, the Water Oak (*Quercus aquatica*) makes its first appearance in fine large trees loaded with a prodigious abundance of acorns. It becomes very common in the marshy bottoms of the southern tributaries of the Arkansas River. It even grows, but always shrubby, along the tortuous course of the creeks of the prairies.

A great part of Sebastian and of the south of Franklin County is occupied by prairies underlaid by clay and shales, and still mostly uncultivated. It is impossible to look at the immense and beautiful plains, which are now used only as pastures for cattle, without regretting that agriculture has not until now been able to procure more out of them. They are too wet, too hard, too clayey, say the farmers, who clear land in the forests

surrounding the prairies, where they find a dry, light soil, mostly red upland, or who even prefer settling on the top of the hills of the Millstone Grit. It does not appear that any fair trial of culture has been made on the prairies of this section. By a fair trial, I mean not only the deep ploughing of the subsoil, but the drainage also. The tenacity of the soil may be easily remedied by the addition of manure, and if it is not at hand, of sand, most abundant on all the declivities of the hills surrounding the prairies. Generally, the proprietors know that the soil can be rendered productive; but they find that the result would not repay the cost and trouble. Moreover, the prairies are well enough as excellent pastures for their cattle. These reasons may suffice at present; but when the population of Western Arkansas increases industry will yet derive a great deal more advantage from these plains.

Near the limits of Sebastian and Franklin Counties, between Vachegrasse Creek, Big Creek, and Doctor's Creek, a series of low hills, formed of the red shales, constitutes the water-shed. It is the same red upland as at Lafayette, and it has the same fertility. It is here mostly cultivated for cotton, and has large plantations. Its average produce is one thousand pounds of cotton per acre. For corn it is not quite as good, producing only an average of about thirty bushels an acre; but better for wheat, twenty bushels being the average, and especially for oats. As it receives part of its mineral elements from the Millstone Grit, it is a light, somewhat sandy soil, which, at least from its appearance, cannot preserve for a long time its productive powers. This soil would be much improved by alternation of heavy grains, or of cotton with oats, cultivated only to be turned in as manure.

Grand Prairie of Franklin County is underlaid by ferruginous black shales, or sometimes by the fireclay of the coal. A few low hills are still left in the middle of it, with the original stratification of the measures to which they belong, a succession of shales and fireclay. Some hills like these, but more abrupt and higher, look like Indian mounds, on the flat surface of Long Prairie, in Sebastian County. Neither humidity nor a peculiar nature of the ground can account for the barrenness of these hills, on which there only grows the same species of herbaceous plants as those of the prairies. In a case like this, the growth of trees has probably been prevented by the annual fire of the prairies. There is no possibility to explain the phenomenon in any other manner.

The bottoms of Hurricane Creek, in the southern part of Franklin County, gave us the first insight into the vegetation of the extensive flats or marshy bottoms which border all the rivers in the south of Arkansas. At this place, the characteristic trees are especially the Water Oak, the Willow Oak, which I see for the first time, but which becomes extremely common the more we advance to the southward. Like the former, it grows to a

large size in the flats: the Pin Oak, the Swamp Chestnut Oak, the Laurel Oak, and the Black Jack, with the Sweet Gum, the Buttonwood, a great thickness of underwood, the Papaw, the Arrowwood, the Dogwood, and especially a great quantity of vines; the Bignonia, the Trumpet Flower, the Greenbriers, and, most common of all, the Supple-Jack.

GEOLOGICAL NATURE OF THE SOIL AND VEGETATION ALONG THE ARKANSAS RIVER, IN FRANKLIN, JOHNSON, POPE, CONWAY, AND PART OF PULASKI COUNTIES.

The sandy banks of the Arkansas River, from Roseville, Franklin County, to Little Rock, is characterized by the same trees as the banks of the Mississippi below the mouth of the Ohio River. This bottom, one to two miles broad, has two terraces. The inferior one, or the first bank, as it is sometimes called, has the Cottonwood, the Willows, the Buttonwood, the Silver Maple, the Ash-leaved Maple, the Nettle Tree, and for underwood, the Kinnikinnik. The upper bank, about fifteen feet higher, has the Black Walnut, the Red Oak, the Quercitron, the Pin Oak, the Swamp Chestnut Oak, the Sweet Gum, the Red Mulberry, the Linden, and for underwood, Papaw, Sassafras, Greenbriers, Brambles, Elder Bushes, and Grape Vines. The lower bottom is too sandy and too much exposed to overflows for cultivation; but the upper bottom is fertile, especially cultivated for cotton. It produces, on an average, one bale of cotton, or fifty bushels of corn, per acre.

Our road to Little Rock, on the north side of the river, passes through a hilly country of the Millstone Grit formation. The ground is rocky, mostly covered with the Yellow Pine, and the Black, the White, the Spanish Oaks, and the Black Jack. The hills divide the creeks running to the Arkansas River. Most of the bottoms of these creeks are broad, flat, marshy, with a dense vegetation of Willow, Water, and Pin Oaks. Some prairies also are seen, apparently underlaid by the red carboniferous shales; but they are of small extent.

From Horsehead Creek to Clarksville, Johnson County, the country changes its physical and geological characters. It is marked by a succession of low hills of the red upland or red shales, and is now nearly all cultivated, especially for cotton. These red shales here generally overlie the black shales of the coal at a distance of fifty to one hundred feet. Thus the deepest creeks are cut through the black shales, and all the hills are formed, at least in the upper part, with the red shales. Sometimes they are overlaid by a bed of flaggy sandstone, which, by the erosion of the soft clay under it, descends along the slopes of the hills, following all the irregularities of the ground by breaking in irregular pieces. In places it

looks like a pavement built by hand. This sandy upland, at its junction with sandstone, loses some of its natural fertility. It becomes dry, too permeable, and easily washed, and produces only eight hundred pounds of cotton, or twenty-five bushels of corn, or twelve bushels of wheat, per acre. Its natural vegetation is the Yellow Pine. When this red upland is flat, it becomes marshy, and forms Post-Oak or grassy flats. They are somewhat extensive along the Spadra Creek, near its mouth. When they can be drained, they give one of the best soils of the country. Thus, at the mouth of the same Spadra Creek, this drained land produces annually from sixteen hundred to two thousand pounds of cotton.

The bottoms of both branches of Piney Creek and of its tributaries, like those of Illinois Bayou, Point-Remove Creek, Cadron, and Alarm Bayou, are generally broad, fertile, and well cultivated, when they are not too wet or marshy. The soil is like that of the Spadra Creek bottoms, a black, deep mould, of the same fertility. The extensive flats of this country, and even the flats and Cypress Swamps of Point-Remove Creek, could be gained for agriculture by a systematic drainage, somewhat costly, it is true. It would be necessary to dig, around a marked area, deep trenches, and to heap the materials along these ditches, like dams around the land, which is thus drained and preserved against the inundations. This system, called the Dutch drainage, because it has not only fertilized a great part of Holland, but reclaimed the land from the sea, has been tried with great advantage along the banks of the Mississippi. I have seen it also attempted in a small way on the banks of the Washita River. The comparison given hereafter of the agricultural produce of this reclaimed soil with that of the dry alluvial upland, will put in full evidence the value of the drainage of the low lands of Arkansas. It is true to assert that the greatest riches of the State still lie buried in the mud of its marshes.

The sandstone on the top of Carrion-Crow Mountain already shows evident traces of metamorphism. It has become so hard and compact that it gives fire under the hammer like flint, and is very difficult to break. Nevertheless, the vegetation of the ridge is exactly the same as that of the ridges of sandstone formerly seen. The trees are scarce, but the herbaceous plants cover the whole of the steep and rocky declivity. After crossing Palarm Bayou near its mouth, in Pulaski County, traces of metamorphism become still more evident by the appearance of thin veins of quartz crossing each other in every direction, and apparently filling numerous irregular fissures in the strata of sandstone. Towards Little Rock, the veins of quartz become larger, and after a little, on the other side of Arkansas River, quartz appears to have been entirely substituted for sandstone. But neither on the north nor on the south side of the Arkansas River does the vegetation change its character by this metamorphism of the rocks. The Pines become perhaps more predominant; but the Black

Oak and Black Jack, the White, the Red, and the Spanish Oaks, even the Mockernut, continue to appear mixed with them, just as they are on the hills formed of the Millstone Grit in Crawford County. Only on the quartz barrens these species are stunted or always of small size, as when they cover the cherty limestone of the North. Along the creeks, which run between the hills, or divides, of the metamorphic region of South Pulaski County, the flats or bottoms are also marshy, and have for natural vegetation the Black Jack, the Willow, and the Water Oaks. And the lowest hills formed of the red shales, which appear to have been less influenced by metamorphic agency than the sandstone, preserve with their color and the fertility of their soil the trees which characterize them in the western counties. Between Little Rock and the Hot Springs, the plantations are scarce, and only established on the bottom land of the rivers, when they are not too wet and have not become *flats*.

THE HOT SPRINGS AND HOT SPRINGS COUNTY.

The vegetation of the Hot Springs, which, by constant deposit of their water, have formed a hill of tufa, perforated with the numerous small openings and basins of their water, demands a separate examination. The surface of this calcareous formation is constantly modified, either by erosion of the water running down its steep declivity or by addition of new matter. It is thus nearly barren and naked in some places. Two species of evergreens have invaded this peculiar ground: the Youpon or Cassena (a species generally inhabiting the sandy coasts of the South), and the Juniper. Few other woody plants grow on the hill of the Hot Springs. Only two or three stunted specimens of the Quercitron, of the Ironwood, and a single tree of the Red Maple. Small plants, especially mosses, which are the first plants attacking a naked rock to decompose it and change it into humus, cover most of its surface, especially in places irrigated by the hot water of the springs. The species mentioned here are not interesting in a practical, but remarkable in a scientific point of view, because they show the growth of some of those small plants to be independent of temperature. The most common of all is *Reboullia hemisphærica* (Rad.), a species of the Liverwort family, and for the mosses, *Bartramia radicalis*, *Bryum argenteum*, *Barbula unguiculata* and *Fissidens taxifolius*. From the family of the Ferns, there is a kind of Maidenhair (*Adiantum Capillus-Veneris* L. and *Cheilanthes Alabamensis*), and from the Phænogamous herbaceous plants, the Wild Senna, the Three-leaved Stonecrop, the Lyre-leaved Sage, the great Lobelia, and *Herpestis nigrescens*, all plants growing so near the hot water of the springs that their roots necessarily are immersed in it. More removed from the influence of the hot water, the French Mulberry, the

Ironweed, the Wild Bergamot and some Greenbrier, vegetate upon the tufa. In the basins which receive the water at the outlets of the springs, three species of Conferva or green filaments are found attached to stones, leaves, or pieces of decayed wood, or investing the woody pipes which carry the water to the bath-houses.

From the Hot Springs to the southwest of the county toward Magnet Cove, the nature of the rocks is changed to a granitic formation, but the vegetation preserves the same character as it had on the quartz, or on the metamorphic sandstone. The banks of the creek which traverses Magnet Cove have the Hornbeam and the Ironwood, with a few Oaks and trees of the Buttonwood. Where they become flat and marshy, they are overgrown by the Water and the Willow Oaks. The low hills and bottoms of the cove are formed of a reddish ferruginous clay, a true iron ore which makes a soil of greater fertility than would be supposed from its rocky barren appearance. It produces, on an average, fifteen hundred pounds of cotton, or fifty bushels of corn, or twenty bushels of wheat, per acre. This soil covers only a small area. From the cove to Rockport, the country is broken by steep, rocky hills, successively exposing the rocks which are passed from the springs, but in a different order, viz., granite, quartz, and then sandstone. Near Rockport, the tops of the sandstone ridges are cultivated. But here we reach the alluvial formations of the Washita River, sand, pebbles, &c., resembling drift, which have been carried by water to a height of about two hundred feet above the actual bed of the river.

GEOLOGICAL NATURE OF THE SOIL AND VEGETATION OF WASHITA RIVER, AND OF CLARK AND DALLAS COUNTIES.

This part of our exploration was not extended far, while the snow soon forced us to abandon the field. Nevertheless, from the identity of geological formations and of physical circumstances in the southern counties of Arkansas, these remarks are probably applicable to the whole region south and east of Hot Springs County, including the cretaceous, tertiary and alluvial formations of the State.

On account of the nature of the soil and of its natural vegetation, the area occupied by these recent formations can be divided into two well characterized sections. 1st. The upland, covered either by a sandy alluvial ground or by red, sandy, sometimes clayey soil, resulting from the decomposition of red tertiary shales, or of sandstone or clay beds of the same formation. 2d. The deep alluvial soil of the bottom lands, or the low swampy ground bordering the rivers and the creeks.

In passing from the old formations of the coal epoch to the recent tertiary and alluvial, the change in the vegetation is marked at once by

the appearance of the Beech, below Rockport, on the banks of the Washita River. It continues southward, becoming more and more common, till it is the prevailing species, or even covers by itself alone low hills of the tertiary or of the cretaceous formations. As not a single Beech tree has been seen either upon the Silurian and subcarboniferous formations of the north, or upon the Millstone Grit and carboniferous strata of the west of Arkansas, this species, at this low latitude, can be admitted as a true characteristic of the tertiary. It could even be considered as a remnant of the vegetation flourishing at the epoch when the tertiary strata were deposited, as its petrified remains, fruit and leaves, are found mixed with the shales of this formation. It is especially upon the red tertiary upland that the Beech flourishes and attains its greatest size. The yellow sandy uplands, mostly derived from tertiary or cretaceous sandstone, are characterized by the Loblolly Pine, which, with the Yellow Pine, grows also upon the alluvial sandy deposits of the rivers, and even descends to their swampy banks. With these trees are seen, upon all the dry uplands and recent formations, the White, the Black, the Spanish Oaks in abundance and of beautiful growth, more rarely, the Shellbark Hickory, the Black Jack and the Post Oak, with the Holly. These three last species, and occasionally the Beech, inhabit also the marshy bottoms of the rivers.

The fertility of the upland soil, both of the alluvial and of the tertiary formation, is the same. This soil is sandy, too light, easily cut in ravines, and carried down the declivities. Its average produce is about eight hundred pounds of cotton, or fifteen bushels of corn, or eight to ten bushels of wheat, to the acre. That cannot be considered encouraging for agriculture. This soil wants the clay substratum of the subconglomerate prairies, or the detritus of the cherty limestone, or what would be equally favorable, a good dressing of animal manure.

The bottom land of Washita River and of the rivers of this section, is covered by a very rich and luxuriant vegetation. The trees, especially the Red and Pin Oaks, the Swamp Chestnut Oak, the Swamp White Oak, the Willow and Water Oak, even the Beech, become there of enormous size. Other species are less abundant: the Overcup Oak (*Quercus lyrata*), which I have not seen elsewhere, the Pecan-nut, the Shellbark Hickory, the Butternut, the Sweet Gum, the Small Laurel Magnolia, with a thick underwood of the Holly, the Sweetleaf (both very abundant), the Wax Myrtle, the Benzoin, two species of Arrow-wood, plenty of Vines, Gelsemium, Greenbriers, Supple-Jack, Grapes and the Cane. The deepest part of the marshy bottoms have the great Tupelo and the Bald Cypress.

Like the bottoms of the Arkansas River, the banks of all these watercourses have two terraces or two levels: the sandy upper bottoms, which have the vegetation and the productive power of the tertiary and alluvial uplands, averaging for their produce eight hundred pounds of cotton, or

twenty bushels of corn, or ten bushels of wheat an acre. The low bottoms or true bottoms, as they are generally called, are exposed to inundation; but when they can be cultivated, produce, annually, eighteen hundred pounds of cotton, or seventy to eighty bushels of corn. Of course wheat cannot be raised on this soil.

Would it not be well for the proprietors of these apparently uncultivable bottoms, to ponder and compare the difference in the results of agricultural pursuit upon the poor upland soil which they cultivate, and the rich lowland which they leave untouched and useless? The difficulties attending the drainage are great indeed; but the cost of digging trenches and building dams would be richly and tenfold repaid.

It would have been well to mention with each of the geological formations of the State a greater number of botanical species as characteristic of the soil. But this examination is already too long, and the following catalogue of the plants naturally growing in Arkansas, indicating the geological and physical relations of each species, as far as they could be ascertained, may supply the deficiency of the general remarks. This catalogue is not the result of my own labor only. Indeed, if I had only quoted the species of plants which I have found myself, the enumeration would have been very incomplete. Dr. D. D. Owen, the Principal Geologist, and Professor E. T. Cox, who visited some counties of Arkansas during the spring, collected many species of plants, which were given me for determination. The species growing in the fall were collected by myself. But by far the greatest number of plants ever collected in Arkansas were seen and published by the celebrated botanist, Nuttall, who, about twenty years ago, spent much time in exploring Arkansas and the western plains. The results of his explorations were at various times published in the memoirs of scientific societies, especially those of the Academy of Sciences of Philadelphia, which are scarcely attainable now. Thus, I considered it a service rendered to science, to mention in this catalogue all the species seen by Nuttall, and which did not come under my examination. These species of Nuttall are marked in the catalogue by a *.

A glance at the amount of practical information, for medicinal, agricultural, and even mechanical purposes, that can be derived from a catalogue of plants like this, will suffice to show the reason of its place in the reports of a State Geological Survey. There is not a farmer, whatever his circumstances are, that would not be benefited by applying the plants to his use, according to their various properties. It is true that, generally, plants, even the most common, are unknown to the inhabitants of the country, and that English names, or popular descriptions, cannot give sufficient indications to direct them to the true species. But if a science be unknown to many, that is no reason to consider it worthless. The only good way to make people acquainted with the useful and the dangerous plants,

would be to direct every botanical surveyor to collect at least twenty-five specimens of each interesting species. With these specimens a number of collections could be formed and deposited either in normal schools or in the academies of the State or in public libraries, in places accessible to teachers. By examining the plants and reading labels bearing the names, habitat, and property of each species, the teacher would be able to know, in a short time, the valuable plants, and to make them known to his pupils.

It is customary to judge everything from the amount of money that it costs and that it brings. In cases like this, knowledge is equivalent to an unappreciable amount of money. If we could compute the sum that is paid every year by the population of a State like Arkansas for useless, dangerous, poisonous drugs, sold everywhere as popular medicines,—drugs which have taken the hard earnings of the poor, destroyed the health of many, killed thousands of people, and cured nobody,—how enormous this sum would appear! Nobody complains, nevertheless. But when scientific researches introduced among the population can give to every one simple directions for the preservation of health, and indicate valuable medicines for cases of sickness, how many there are who, looking to the cost only, consider these researches as useless and too expensive. Acquaintance with the plants and their properties is advantageous to every one; but becomes a necessity for the inhabitants of the country; where cattle, negroes and children are exposed to die without any rational assistance, when the means of saving them are just at hand, contained in some unknown plant.

A CATALOGUE OF THE PLANTS OF ARKANSAS.[1]

Latin Names.	English Names.	Geolog'l Station.	Natural Habitat.
	Ranunculaceæ.[2]	*Crowfoot Family.*	
Clematis, L.,	Virgin-Bower.		
C. ochroleuca, Ait.,		Sandstone,	Rocky creeks.
C. Pitcheri, Tor. & Gr,		Limestone,	Banks and prairies.
C. Virginiana, L.,[3]	Common Virgin-Bower,	Limestone,	Woods and thickets.
Anemône, L.,	Windflower.		
? A. Caroliniana, Walt.,[4]			
A. Virginiana, L.,	Tall anemone,		Prairies and open woods.
Hepatica, Dill.,	Liver-leaf.		
H. acutiloba, D C.,		Limestone,	Shady woods.
Thalictrum, Tourn.,	Meadow-Rue.		
? T. anemonoides, Mich.,	Rue-Anemone,		Prairies.
T. Cornuti, L.,	Meadow-Rue,		Wet prairies.
Ranunculus, L.,	Crowfoot.		
R. Purshii, Rich.,	Yellow water Crowfoot,		Mammoth springs.
? R. abortivus, L.,	Small flowered Crowfoot,		Prairies.
? R. Pennsylvanicus, L,	Bristly Crowfoot,		Damp woods and bottoms.
R. repens, L,	Creeping Crowfoot,		Marshes.
? R. parviflorus, L.,			"
Myosurus, Dill.,	Mouse-Tail.		
*M. minimus, L.,		Alluvial,	Fields.
Isopyrum, L.			
*I. biternatum, T. & Gr,		Alluvial,	Moist shady places.
Caltha, L.,	Marsh Marigold.		
C. palustris, L.,[5]		Limestone,	Springs.

[1] The English names of this Catalogue are taken from Prof. Asa Gray's Manual of the Botany of the United States. The order of enumeration is also taken from the same excellent book. The properties of the plants are indicated from such authorities as Haller, Barton, De Candolle, &c.

[2] Herbs or climbing shrubs, with an acrid and caustic juice sometimes poisonous, but mostly destroyed by heat in drying or cooking the plants.

[3] Climbing shrub with white small flowers and carpels or fruits conspicuously feathery. A plant with very acrid juice, to which the milk sickness has been sometimes ascribed.

[4] Species marked with a ? have not been seen in Arkansas, but are supposed to be there.

[5] Plant acrid and dangerous when green; but eaten boiled as *greens*. Sometimes named Cowslips. Easily known by its shining bright yellow large flowers and its kidney-shaped leaves. Generally grows in water, the first flower in the spring.

Latin Names.	English Names.	Geolog'l Station.	Natural Habitat.
Aquilegia, Tourn.,	Columbine.		
A. Canadensis, L.,		Limestone,	Rocky and shady banks.
Delphinium, Tourn.,	Larkspur.		
D. tricorne, Mich.,	Dwarf Larkspur,	Sandy,	Damp woods.
D. azureum, Mich.,		Alluvial,	Prairies.
*D. virescens, Nutt.,			"
Hydrastis, L.,	Yellow Puccoon.[1]		
*H. Canadensis, L.,[1]			Woods and banks.
Actæa, L.,	Baneberry.		
*A. Americana, Pursh.,[2]		Lime soil,	Rich woods.
Cimicifuga, L.,	Bugbane.		
C. racemosa, Ell.,[3]	Blacksnake root,	Limestone,	Woods and hills.

Magnoliaceæ.

Magnolia. L.			
M. glauca, L.,[4]	Small Laurel Magnolia,	Alluvial,	Deep swamps and bottoms.

Annonaceæ. *Custard-Apple Family.*

Asimina, Adam,	Papaw.		
A. triloba, Dun.,[5]		Alluvial limestone,	Banks and rich bottoms.
Cocculus, D C.			
*C. Carolinus, D C.,		Alluvial,	River banks, climbing.

Menispermæ.

Menispermum, L,	Moonseed.		
M. Canadense, L.,		Alluvial,	Banks.
M. Lyoni, Pursh.,		"	"

Berboridaceæ.

Jeffersonia, Bart.,	Twin leaf.		
? J. diphylla, Pers.,		Limestone,	Woods.
Podophyllum, L.,	May-Apple.		
P. peltatum,[6]			Woods and meadows.

[1] The same name with that of Yellow-Root, is given also to *Zanthoriza apiifolia*, L'Her., which also probably grows in Arkansas. The roots of both species are bitter and tonic, employed also for dyeing yellow. The color is not fast.

[2] Both varieties with red and white fruits, sometimes named *Necklace weed*, are found in Arkansas. Fruit beautiful, in grapes, poisonous. Root bitter, employed as astringent for gargarisms.

[3] Has a long (one to two feet) raceme of white flowers successively opening from the base up, and black round sessile fruits. The decoction of the root is a useful family medicine in cases of rheumatism, dropsy, and especially of the St. Vitus dance.

[4] I have not seen any other species of Magnolia in Arkansas. Its aromatic fruit, infused in brandy, is employed as a remedy for Rheumatism. Its bark is said to be as good as that of the Cinchona against intermittent fevers. Wood scarcely used, good for joiners' tools.

[5] Fruit edible, can be much improved by cultivation.

[6] Fruit edible, not purgative. A light decoction of it in milk serves to alleviate the cough of the consumptives. Leaves poisonous.

Latin Names.	English Names.	Geolog'l Station.	Natural Habitat.
Nympheaceæ and Nelumbiaceæ.[1]			
Nelumbium, Juss.,	Nelumbo. Sacred-bean.		
N. luteum, Willd.,[2]			Ponds along the Mississip.
Nymphæa, Tourn.,	Water-Lily.		
N. odorata, Ait.,			Ponds and deep swamps.
Nuphar, Sm.,	Pond-Lily.		
N. advena, Ait.,			Bayous and slow streams.
Sarraceniaceæ. *Pitcher-Plants.*			
Sarracenia, Tourn.,[3]	Huntsman's cup.		
? S. rubra, Walt.,			Marshes.
Papaveraceæ. *Poppy Family.*			
Stylophorum, Nutt.,	Celandine-Poppy.		
S. diphyllum, Nutt,		Limestone,	Shady woods.
Sanguinaria, Dill.,	Blood-root.[4]		
*S. Canadensis, L,		Light soil,	Open woods.
Fumariaceæ. *Fumitory Family.*			
Corydalis, D C.			
*C. aurea, Willd.,		Sandstone,	Rocky woods.
Cruciferæ.[5] *Mustard Family.*			
Cheiranthus, R. Br.			
*C. hesperidoides, T. & Gr.,		Alluvial,	Banks of rivers.
Nasturtium, R. Br.,	Water cress.		
*N. tanacetifolium, H. & A.,		Alluvial,	Damp soil.
*N. sinuatum, Nutt.,			Banks.
N. officinale, R. Br.,	Water-cress,	Limestone,	Mammoth Springs.[6]
? N. palustre, D C.,	Marsh cress,		Streams.
Streptanthus, Nutt.			
*S. obtusifolius, Hook.,		Limestone,	Hot Springs.
*S. maculatus, Nutt.,			Rocks.
Dentaria, L.,	Pepper-root.		
? D. laciniata, Muhl,		Alluvial,	Shady banks.

[1] Water plants, with large floating leaves and white odorous or yellow flowers. Roots farinaceous, sometimes used for food.

[2] Tubers and seeds eatable.

[3] No species of this genus is mentioned by the authors as found in Arkansas. I have seen none. But some ought to be found in the marshes of the sunk country.

[4] Root used as vermifuge, emetic and purgative. Given especially to horses to destroy Bots. A well-known plant with large white flowers appearing before the leaves in the first spring. Root with a blood-red juice.

[5] Species of this family have generally an acrid or bitter sap, either concentrated in the seeds as in the mustard, or distributed in the leaves as in the water-cress, or in the roots as in the Horse-Radish. This sap is stimulant and anti-scorbutic. No dangerous principle is found in any species of this useful family, which includes the Cabbage, the Turnip, and some of our finest garden-flowers.

[6] Probably introduced by Indians with the Mint.

Latin Names.	English Names.	Geolog'l Station.	Natural Habitat.
Cardamine, L.,	Bitter cress.		
? C. rhomboidea, D C.,		Alluvial,	Marshy bottoms.
*C. hirsuta, L.,		Limestone,	Wet places and rocks.
*C. Ludoviciana, Hook.			
Arabis, L.,	Rock cress.		
A. hirsuta, Scop.,		Limestone,	Rocks.
A. lævigata, D C.,		"	"
A. Canadensis, L.,		"	"
Laevenworthia, Torr.			
*L. aurea, Por.,			Wet places.
Erysimum, L.,	Treacle-Mustard.		
*E. cheiranthoides, L.,	Worm-Mustard,	Limestone,	Along streams.
*E. Arkansanum, Nutt.,	Western Wallflower,	"	Open plains and banks.
Sisymbrium, All.,	Hedge-Mustard.		
*S. canescens, Nutt.,	Tansy-Mustard,		Dry open plains.
Selenia, Nutt.			
*S. aurea, Nutt.,			Wet prairies.
Draba, L.,	Whitlow grass.		
*D. cuneifolia, Nutt.,			Grassy places.
*D. Caroliniana, Walt.,		Sandstone,	Sandy fields.
*D. micrantha, Nutt.,			Rocky places.
Vesicaria, Lam.,	Bladder pod.		
*V. repanda, Nutt,			Banks of Red River.
*V. angustifolia, Nutt.,			Prairies.
*V. Nuttallii, T. & Gr.,			"
Capsella, Vent.			
C. bursa-pastoris, M.,	Shepherd's purse,		Waste fields. Introduced.
Lepidium, L.,	Pepper-grass.		
L. Virginicum, L.,		Sand,	Fields and roads.
Senebiera, D C.,	Swine cress.		
*S. didyma, Pers.,			Fields and banks.

Capparidaceæ.[1] *Caper Family.*

Cleomella, D C.			
*C. Mexicana, D C.			
Cleome, L.			
*C. serrulata, Pursh.,		Sand,	Banks of Arkansas River.
Polanisia, Raf.			
P. graveolens, Raf.,		Limestone,	Gravelly banks, &c.
Cristatella, Nutt.			
*C. erosa, Nutt.,		Sandstone,	Hills of Red River.
*C. Jamesii, T. & Gr.,		"	" "

Violaceæ.[2] *Violet Family.*

Solea, D C.,	Green Violet.		
*S. concolor, Gin.,			Thickets.

[1] Same properties as the former family.
[2] Roots somewhat emetic. Leaves and stems employed as cataplasms in diseases of the skin.

LATIN NAMES.	ENGLISH NAMES.	GEOLOG'L STATION.	NATURAL HABITAT.
Viola, L.,	Violet.		
V. pedata, L.,	Bird-foot Violet,	Sandstone,	Rocky prairies.
V. palmata, L.,	Hand-leaf Violet,	"	Shady places.*
V. cucullata, Ait.,	Common blue Violet,	. . . .	Open woods and hills.
V. sagittata, Ait.,	Arrow-leaved Violet,	Sandstone,	Woody hills.
V. hastata, Mich.,	Halbert-leaved Violet,	"	" "
*V. tricolor, L.,	Pansy,	. . . .	Fields and dry hills.
Ionidium, Vent.			
*I. stipulaceum, Nutt.,	. . . .	Sandy,	Plains of Red River.

Cistaceæ. *Rock-Rose Family.*

Helianthemum, Tour.,	Rock-rose.		
? H. Canadense, Mich.,	Frost weed,	Sandstone,	Dry soil and rocks.
*H. polifolium, T. & Gr.,	. . . .	Sandy,	Dry sterile places.
Lechea, L.,	Pinweed.		
L. major, Mich.,	. . . .	Sand and chert,	Dry woods.
L. minor, Lam.,	. . . .	"	Sterile places. Hills.

Droseraceæ.[1] *Sundew Family.*

Drosera, L.,	Sundew.		
? D. rotundifolia, L,	. . . .	. . . .	Bogs.

Parnassieæ.

Parnassia, Tourn.,	Grass of Parnassus.		
P. Caroliniana, Mich.,	. . . .	Limestone,	Mammoth Spring.

Hypericaceæ.[2] *St. John's wort Family.*

Ascyrum, L.,	St. Peter's wort.		
A. Crux-Andreæ, L,	St. Andrew's cross,	Sandstone,	Pine woods.
Hypericum, L.,	St. John's wort.		
H. prolificum, L.,	. . . .	Sandstone,	Shady, rocky banks.
H. adpressum, Bart.,	. . . .	. . . .	Wet prairies.
H. corymbosum, Muhl.,	. . . .	. . . .	Woods and meadows.
H. nudiflorum, Mich.,	. . . .	. . . .	Borders of swamps.
H. mutilum, L.,	. . . .	Limestone,	Banks and prairies.
H. Canadense, L.,	. . . .	Sandy,	Roads on prairies.
*H. Drummondii, T. & Gr.			
Elodea, Pursh.,	Marsh St. John's wort.		
*E. petiolata, Pursh.,	. . . .	. . . .	Swamps.

[1] No species of this family has been mentioned in Arkansas. But probably they have escaped observation. These small plants grow among mosses (*Sphagnum*) in bogs.

[2] The sap of these plants is generally bitter, astringent and febrifuge.

LATIN NAMES.	ENGLISH NAMES.	GEOLOG'L STATION.	NATURAL HABITAT.
	Caryophyllaceæ.[1] *Pink Family.*		
Saponaria, L.,	Soapwort.		
S. officinalis, L.,			Roadsides. Introduced.
Silene, L.,	Catchfly.		
*S. stellata, Ait.,	Starry Campion,	Sandstone,	Dry woods.
S. antirrhina, L.,	Sleepy Catchfly,	"	" "
? S. Virginica, L.,	Fire Pink,		Open woods.
Agrostemma, L.,	Corn-Cockle.		
A. githago, L.,			Wheat fields. Introduced.
Arenaria, L.,	Sandwort.		
A. stricta, Mich.,		Limestone,	Rocks and barren.
*A. tenella, Nutt.,			Rocky places.
*A. Pitcheri, Nutt.,			Prairies.
Stellaria, L.,	Chickweed.		
*S. Nuttallii, T. & Gr.,			Prairies.
*S. macropetala, T. & Gr.			
? S. lanuginosa, T. & Gr.,			Shady places.
Cerastium, L.,	Mouse-ear Chickweed.		
C. vulgatum, L.,			Waste places. Introduced.
Anychia, Mich.,	Forked Chickweed.		
A. dichotoma, Mich.,		Limestone,	Sterile rocky ground.
Paronychia, Tourn.,	Whitlow-wort.		
P. dichotoma, Nutt.,		Limestone,	Rocks.
Mollugo, L.,	Indian Chickweed.		
M. verticillata, L.,	Carpet-weed,	Sand,	Barren.
	Portulacaceæ.[2] *Purslane Family.*		
Portulaca, L.,	Purslane.		
P. oleracea, L.,			Cultivated ground. Introd.
*P. pilosa, L,		Sand,	Barren.
Talinum, Adans.			
*T. teretifolium, Pursh.,		Limestone,	Naked rocks.
Claytonia, L.,	Spring beauty.		
C. Virginica, L.,		Alluvial, &c.,	Low rich ground.
	Malvaceæ.[3] *Mallow Family.*		
Althæa, L,	Marsh Mallow.		
A. officinalis, L.,			Gardens.
Malva, L,	Mallow.		
M. rotundifolia, L.,	Common Mallow,		Roadsides. Introduced.
*M. papaver, Car.,			Prairies.

[1] No particular properties ascribed to plants of this family. The Saponaria, soap wort, is used for soap, and sometimes as a wash in syphilitic diseases of the skin.

[2] Purslane, like the Spring-beauty, are eaten as greens, cooked, or raw for salad.

[3] Plants of this family contain a demulcent mucilage used as cataplasm or as emollient drink. The Cacao (Theobroma) and the Cotton (Gossypium herbaceum) belong to this family.

Latin Names.	English Names.	Geolog'l Station.	Natural Habitat.
Callirrhoë, Nutt.			
C. digitata, Nutt.,		Limestone,	Rocky, open places.
*C. pedata, T. & Gr.,			" "
Gossypium, L.,	Cotton.		
G. herbaceum, L,			Cultivated.
Sida, L.			
S. spinosa. L.,		Sand,	Dry sterile places.
Abutilon, Tourn.,	Indian Mallow.		
A. Avicennæ, Gärt.,	Velvet-leaf,		Waste places, &c. Introd.

Tiliaceæ.[1] *Linden Family.*

Tilia, L.,	Basswood.		
T. Americana, L.,		Limestone,	Banks.
? T. alba, Mich.,			"

Meliaceæ. *Bead-Tree Family.*

Melia, L.,	Pride of India.		
M. azedarach, L.[2]			

Linaceæ.[3] *Flax Family.*

Linum, L,	Flax.		
L. Virginianum, L,	Wild flax,	Sandy,	Borders of prairies.
L. perenne, L.,		Limestone,	Prairies.

Oxalidaceæ.[4] *Wood-Sorrel Family.*

Oxalis, L.,	Wood sorrel.		
O. violacea, L.,	Violet wood sorrel,	Sandstone,	Rocky woods.
O. stricta, L.,	Yellow wood sorrel,		Cultivated ground.

Geraniaceæ. *Cranesbill Family.*

Geranium, L.,	Cranesbill.		
G. maculatum, L.,[5]	Wild Cranesbill,	"	Thickets and prairies.
? G. Carolinianum, L.,		Sandy,	Barren places.

[1] The plants of this family have nearly the same properties as the Mallows. The bark of the Basswood is used for making ropes and coarse cloth. Its wood is soft, white. The fruit has been prepared for making chocolate. The tea of the flowers an edulcent, cooling, and valuable drink.

[2] The fruit of this tree, which is cultivated as ornament, is said to be poisonous, though eaten by birds and children. Used as a vermifuge. Its pulp, says Michaux, is good against scurfy sickness. A decoction of the bark as tea is vermifuge and also purgative. Used for intermittent fevers.

[3] Plants of this family are known by the use of the fibres of the stems. The seeds of the common Flax (*Linum usitatissimum*, L.) are emollient as cataplasm, and yield a valuable oil. The Cotton has banished the Flax from the Southern States.

[4] All the species of this family contain a considerable quantity of oxalate of potash, which gives to the plants an agreeable taste and cooling, laxative properties.

[5] Plant with short, branching stems, leaves cut in three or five divisions, large purplish flower, and long-beaked capsule. Much used as family medicine. Root (collected in autumn) astringent, without bitter taste, useful in diarrhœa, children cholera, loss of blood, stone in the bladder.

Latin Names.	English Names.	Geolog'l Station.	Natural Habitat.
	Balsaminaceæ.[1] *Balsam Family.*		
Impatiens, L.,	Jewel-weed.		
I. pallida, Nutt.,	Pale Touch-me-not,	Limestone,	Mammoth Spring.
? I. fulva, Nutt.,	Spotted Touch-me-not,	"	Wet shady places.
	Rutaceæ. *Rue Family.*		
Zanthoxylum, Col.,[2]	Prickly Ash.		
? Z. Americanum, Mill.,	"	Limestone,	Rocky places.
*? Z. Carolinianum, N.,		"	" "
*Z. macrophyllum, Nutt.,[3]			" "
Ptelea, L.,	Hop-tree.		
P. trifoliata, L.,[4]	"	Limestone,	Rocky banks.
Ailanthus, Desf.,	Chinese Sumach.		
A. glandulosus, Desf.,[5]			Cultivated.
	Anacardiaceæ.[6] *Cashew Family.*		
Rhus, L.,	Sumach.		
*R. cotinoides, Nutt.,		Limestone,	Banks of Grand River.
R. glabra, L.,	Smooth Sumach,	"	Rocky, barren places.
R. typhina, L.,	Staghorn Sumach,		Hillsides and prairies.
R. copallina, L.,	Dwarf Sumach,	"	Barren.
? R. venenata, D C.,[7]	Poison Sumach,		Swamps.
R. Toxicodendron, L.,[8]	Poison Ivy,	Mostly climbing,	Barren and rich land, &c.
R. aromatica, Ait.,	Fragrant Sumach,	Limestone,	Rocks and barren.
	Vitaceæ. *Vine Family.*		
Vitis, Tour.,	Grape.		
*V. bipinnata, T. & Gr.,			Damp, rich bottoms.
*V. incisa, Nutt.,			Prairies and copses.
*V. indivisa, Willd.,			Swamps and bottoms.
V. labrusca, L.,	Northern Fox grape,	Limestone,	Moist thickets.
V. aestivalis, Mich.,	Summer grape,	Cherty limestone,	Dry rocky places.
*V. cordifolia, Mich.,	Frost grape,		Thickets along rivers.
*V. riparia, Mich.,[9]			" " "
V. vulpina, L.,	Muscadine,	Limestone,	Rocky places.

[1] Fine name, but no valuable property.

[2] Shrubs with pinnate leaves and prickly stems. Bark bitter, aromatic, causing in the mouth the flow of saliva; used against toothache, paralysis of the tongue and of the muscles of the mouth. Also a sudorific medicine.

[3] Nuttall says that this species grows in Arkansas rather than the former.

[4] Fruit bitter, aromatic, used as a substitute for Hops in the fabrication of beer.

[5] Fine shade tree, but objectionable on account of the bad odor of the flowers and its disposition to run.

[6] No American species of this family has any good property. Some species are poisonous.

[7] Very poisonous. I have not seen it in Arkansas, but people said it was abundant in the swamps.

[8] Poisonous, like the former, to the touch. Milk sickness is attributed to it in some countries.

LATIN NAMES.	ENGLISH NAMES.	GEOLOG'L STATION.	NATURAL HABITAT.
Ampelopsis, Mich.,	Virginian creeper.		
A. quinquefolia,	"	Limestone,	Alluvial in woods.

Rhamnaceæ.[1] *Buckthorn Family.*

Berchemia, Neck.,	Supple Jack.		
B. volubilis, D C.,			Damp rich bottoms.
Rhamnus, Tourn.,	Buckthorn.		
? R. lanceolatus, Pursh.,		Limestone,	Cliffs.
R. Carolinianus, L.,	Alder Buckthorn,		Barren banks, &c.
Ceanothus, L.,	New Jersey tea.		
C. Americanus, L.,	" "	Sandy,	Dry thickets and prairies.
*C. ovalis, Bigel.,		"	Rocky places.

Celastraceæ. *Staff tree Family.*

Celastrus, L.,	Staff-tree.		
? C. scandens, L.,	Waxwork,		Thickets.
Euonymus, Tourn.,[2]	Spindle-tree.		
E. atropurpureus, Jack.,	Burning bush,		Shady places, thickets, &c.
? E. Americanus, L.,	Strawberry bush,		Rocky shady places.

Sapindaceæ. *Soapberry Family.*

Staphylea, L.,	Bladder-nut.		
S. trifolia, L.,	" "	Limestone,	Thickets and banks.
Aesculus, L.,[3]	Buckeye.		
*A. Pavia, L.,	Red Buckeye,	Limestone,	Alluvial soil. Thickets.
? A. flava, Ait.,	Sweet Buckeye,	"	Rich bottoms.
Sapindus, L.,	Soap-berry.		
*S. marginatus, Willd.,		Sandy,	Banks of rivers.

Acerineæ. *Maple Family.*

Acer, Tour.,	Maple.		
A. saccharinum, L.,[4]	Sugar maple,	Limestone,	Shady banks.
A. dasycarpum, Ehr.,[5]	Silver maple,	" and sandy,	River banks.
? A. rubrum, L.,[6]	Red maple,	" alluvial,	Swamps and banks.
Negundo, Moen.,	Ash-leaved maple.		
N. aceroides, M.,[7]		Lime'one, alluvial,	Low grounds.

[1] Bark and fruit of species of this family are generally purgative, and sometimes vomitive.

[2] Wood hard, tough, used for spindles, and by watchmakers for cleaning-wood.

[3] Fruit abounds in potash and starch. Bark bitter, tonic, good for tanning and dyeing yellow Wood soft.

[4] Very rare in Arkansas. Wood strong, heavy, not durable, used for cabinet work; slow seasoning.

[5] Wood white, fine-grained, softer than any other maple.

[6] Wood fine-grained, light, employed for chairs, stocks of guns, &c. Probably grows in Arkansas.

[7] Common in Arkansas. Generally in a rich lime soil. Wood fine and even-grained, yellowish veined, used for cabinet-work.

LATIN NAMES.	ENGLISH NAMES.	GEOLOG'L STATION.	NATURAL HABITAT.
	Polygalaceæ. *Milkwort Family.*		
Polygala, Tour.,[1]	Milkwort.		
*P. purpurea, L.,			Wet meadows, prairies.
P. lutæa,		Sand,	Barren.
*P. incarnata, L.,			Dry soil, prairies.
P. verticillata, L.,		Sand,	Fields and barren.
*P. fastigiata, Nutt.,			Prairies and barren.
Krameria, Loefl.,			
*K. lanceolata, Tor.,		Sand,	Barren.
	Leguminosæ.[2] *Pulse Family.*		
Lupinus, Tour.,	Lupine.		
? L. villosus, Willd.,		Sand,	Barren.
Crotolaria, L.,	Rattle-box.		
C. sagittalis, L.,		Cherty Limestone,	Barren.
Trifolium, L.,[3]	Clover.		
T. arvense, L.,	Stone clover,	Sandy,	Fields and barren.
T. pratense, L.,	Red clover,		Cultivated.
T. reflexum, L.,[4]	Buffalo clover,	Alluvial,	Woods and meadows.
T. repens, L.,	White clover,		Old fields.
*T. Carolinianum, Mich.,[5]		Sandy,	Fields.
Hosackia, Doug.			
*Purshiana, Bent.,			Prairies.
Psoralea, L.			
*P. linearifolia, T. & Gr.			
*P. digitata, Nutt.,		Sand,	Hills of Arkansas River.
*P. floribunda, Nutt.,			Prairies.
*P. cryptocarpa, T. & Gr.			
*P. eglandulosa, Ell.,			Dry soil.
*P. simplex, Nutt.,			Plains of Red River.
P. melilotoides, Mich.,		Sand,	Prairies and barren.
Dalea, L.			
*D. laxiflora, Pursh.,			Prairies.
*D. lanuginosa, Nutt.,		Sand,	Banks of Arkansas River.
*D. aurea, Nutt.,			Prairies.
D. alopecuroides, Willd.,		Sand,	Banks.

[1] Roots bitter, astringent, tonic; employed against the bite of snakes, against dysentery, &c. Properties not well known.

[2] Properties different. Some species are strongly purgative, some vermifuge, most of them nutritive, either for man by the seeds like the beans, or for cattle by the stems and leaves like the clover. Some species give a blue color used for dyeing; some are most useful gums. Gum Arabic, Copabes, Balm of Peru, &c.

[3] Some species, especially Red clover, are introduced for cultivation. Benefiting the soil, especially when turned in.

[4] An American species. Flowers as large as the Red clover. Merits to be tried for cultivation.

[5] Species of sweet clover (Melilotus) and of Lucerne (Medicago) are numerous and much cultivated in Europe; but our American climate is too dry for such culture.

Latin Names.	English Names.	Geolog'l Station.	Natural Habitat.
Petalostemon, Mich.			
*P. multiflorum, Nutt.,			Prairies.
P. candidum, Mich.,			Dry prairies.
*P. phleoides, T. & Gr.			
P. violaceum, Mich.,		Limestone,	High prairies.
*P. decumbens, Nutt.,			Plains of Red River.
Amorpha, L.,	False Indigo.		
A. fruticosa, L.,		Sandstone,	Rocky creeks.
*A. paniculata, T. & Gr.,			Prairies.?
*A. canescens, Nutt.,[1]	Lead plant,		Dry prairies.
Robinia, L.,	Locust-tree.		
R. Pseudacacia, L.,[2]	White Locust,	Limestone,	Rocky places and prairies.
R. hispida, L.,		Sandstone,	Dry barren hills.
Sesbania, Pers.			
*S. macrocarpa, Muhl.,			Wet places.
Tephrosia, Pers.,	Hoary Pea.		
T. Virginiana, Pers.,	Goat's Rue,	Sandstone,	Dry barren hills.
*T. onobrychoides, Nutt.,			Plains of Red River.
T. spicata, T. & Gr.,		Sandstone,	Dry barren places.
? T. hispidula, Mich.,		"	" "
Glycyrrhiza, Tour.,	Liquorice.		
*G. lepidota, Nutt.,			Banks of rivers.
Indigofera, L.,	Indigo plant.		
*I. leptosepala, Nutt.,			Plains of Arkansas River.
Astragalus, L.,	Milkvetch.		
*A. trichocalyx, Nutt.,			Prairies.
*A. pachycarpus, T. & Gr.,			Prairies.
*A. distortus, Nutt.			
*A. Nuttallianus, D C.,			"
? A. Canadensis, L.,		Sandy,	Thickets.
? A. Mexicanus, D C.,			Prairies.
Aeschynomene, L.,	Sensitive Joint Vetch.		
A. hispida, Willd.,		Sand,	Plains.
Desmodium, D C.,	Tick Trefoil.		
D. nudiflorum, D C.,		Sandstone,	Rocky woods.
D. acuminatum, D C.,			" "
D. pauciflorum, D C.,			Hilly woods.
D. Canadense, D C.,			Dry woods and prairies.
D. canescens, D C.,			Rich soil, prairies.
*D. cuspidatum, T. & Gr.,			Banks of rivers and roads.
*D. viridiflorum, Beck.,		Alluvial,	Woody bottoms.
*D. rhombifolium, D C.,		"	Dry rich soil.
? D. ciliare, D C.,			Dry hills and copses.
*D. rigidum, D C.,			Open woodland.

[1] Said to grow on lead-bearing rocks. I did not see it in Arkansas.

[2] Valuable species. Common in Arkansas, but often a shrub. Wood greenish, yellow, brown-veined, fine-grained, strong, resisting decay better than any other wood. Used in naval architecture and in cabinet-work. Much exported to England, but becoming scarce. Leaves excellent food for cattle. Roots sweet-tasted.

LATIN NAMES.	ENGLISH NAMES.	GEOLOG'L STATION.	NATURAL HABITAT.
D. sessilifolium, T. & Gr.,			Prairies.
? D. rotundifolium, D C.,			Dry soil.
D. paniculatum, D C.,			Woods and prairies.
Lespedeza, Mich.,	Bush clover.		
L. procumbens, Mich.,		Chert & Sandstone,	Rocky woods.
L. repens, Bart.,		" "	Dry soil, barren.
L. violacea, Pers..		Sand,	Woods and thickets.
*L. Stuvei, Nutt.,		Limestone,	Barren and hills.
L. hirta, Ell.,		Sandstone, &c.,	Dry rocky prairies.
L. capitata, Mich.,		"	" "
Stylosanthes, Sw.,	Pencil flower.		
S. elatior, Sw.,		Sand,	Barren.
Vicia, Tour.,	Vetch Tare.		
V. Americana, Walt.,			Borders of thickets.
V. Caroliniana, Walt.,			Banks of prairies.
*V. Lævenworthii, T. & Gr.			
*V. micrantha, Nutt.,			Prairies and woods.
Lathyrus, L.,	Everlasting Pea.		
*L. pusillus, Ell.,			Prairies?
Phaseolus, L.,	Kidney-Bean.		
? P. perennis, Walt.,	Wild Bean,	Limestone,	Rocky banks.
*P. leiospermus, T. & Gr.,			Plains.?
Dolichos, L.			
*D. multiflorus, T. & Gr.,		Alluvial,	Banks.
Apios, Boer.,	Ground-nut.		
A. tuberosa, Moen.,		Alluvial,	Shady fertile soil.
Rhynchosia, D C.,			
R. tomentosa, T. & Gr.,		Sandstone,	Dry open places.
*R. latifolia, Nutt.,			Woods.
Galactia, R. Br.,	Milk Pea.		
*G. pilosa, T. & Gr.,		Sandstone,	Dry open woods.
Amphicarpaea, Ell.,	Hog pea-nut.		
A. monoica, Nutt.,			Woodland, thickets.
*A. Pitcheri, T. & Gr.,			Plains of Red River.
Clitoria, L.,	Butterfly-pea.		
C. Mariana, L.,		Sand?	Dry soil. (M. Cox.)
Baptisia, Vent.,	False Indigo.		
*B. lanceolata, Ell.,		Sandstone,	Dry rocky soil.
*B. villosa, Ell.			
*B. sphærocarpa, Nutt.,		Alluvial,	Plains.
B. leucophæa, Nutt.,		Sandstone,	Banks of rivers.
*B. australis, R. Br.,			" "
B. leucantha, T. & Gr.,			Rich soil.
Sophora, L.			
*S. affinis, T. & Gr.,			Prairies.
Cercis, L.,	Red-Bud.		
C. Canadensis, L.,[1]		Alluvial,	Rich banks and bottoms.

[1] Common in Arkansas. Wood hard, finely veined, susceptible of good polish. Buds preserved in vinegar for pickles.

Latin Names.	English Names.	Geolog'l Station.	Natural Habitat.
Cassia, L.,	Senna.		
C. Marilandica, L.,[1]	Wild Senna.	Alluvial Lime.,	Fat bottoms.
*C. obtusifolia, L.,			Dry soil.
C. chamæcrista, L.,	Partridge pea,	Limestone chert,	Sandy and rocky prairies.
Gymnocladus, Lam.,	Coffee-tree.		
G. Canadensis, Lam.,[2]			Banks of rivers.
Gleditschia, L.,	Honey Locust.		
G. triacanthos, L.,[3]	Black Locust,	Limestone,	Rich soil, barren, wet, and dry bottoms.
Schrankia, Willd.,	Sensitive Briar.		
S. uncinata, Willd.,		Sand,	Barren and prairies.
Desmanthus, Willd.			
D. brachyloba, D C.,		Sandy,	Prairies and banks.
*D. Jamesii, T. & Gr.,			Sources of Canadian River.
*D. leptolobus, T. & Gr.,			Prairies. ?
Acacia, Neck.			
*A. lutea, Lea.,			Prairies.
*A. hirta, Nutt.,			Plains of Red River.

Rosaceæ.[4] *Rose Family.*

Prunus, L.,	Plum and Cherry.		
P. Americana, Mart.,[5]	Wild plum,	Alluvial lime, &c.,	Banks and thickets.
*P. Chicasa, Mich.,	Chickasaw plum,		
P. pumila, L.,	Dwarf cherry,	Limestone,	Rocky banks.
P. serotina, D C.,[6]	Wild black cherry,	M. G. and sandst.,	Alluvial woods.
*P. Caroliniana, Mich.,		Limestone,	Rocky banks.
Spiræa, L.,	Meadow sweet.		
S. opulifolia, L.,	Nine bark,	Limestone,	Banks and rocky creeks.
*S. aruncus, L.,		"	Shady and rocky creeks.
Gillenia, Moench,	Indian Physic.		
G. stipulacea, Nutt.,[7]	American Ipecac,	Sandstone,	Dry sterile soil.

[1] The leaves are very valuable as purgative in intermittent fevers. The plant abounds where the fever is endemic.

[2] Wood hard, tough, strong, good for building and cabinet-making. Bark very bitter.

[3] Wood hard, fifty-two pounds per cubic feet when dry. Difficult to split; not much used, except for fences as sapling. Grows everywhere, but likes limestone soil.

[4] Plants generally with an astringent principle, which makes some species useful in medicine as febrifuge, or against dysentery. Some have been compared to Cinchona. This principle is found diluted in most of the fruits, apples, pears, cherries, plums, peaches, &c., and renders them most wholesome food in the fall. The kernels of some fruits of this family give by distillation Prussic acid, a violent poison. Useful gums exude from some trees of this most interesting family, which gives us our finest flowers for the garden.

[5] Is much improved by cultivation. *Prunus spinosa* has been introduced for hedges.

[6] A large tree, common in Arkansas. Wood compact, fine-grained, susceptible of brilliant polish good for cabinet-work. The bark, branches, and roots have an aromatic taste, and are tonic. The fruit in Brandy is a cordial against fevers.

[7] Flower white, with erect a little unequal petals. Leaves cut in three, with divisions doubly dentate, with a large stipule at the base. Many properties have been attributed to it without reason. It has a bitter and pungent taste. Always grows on a poor soil.

Latin Names.	English Names.	Geolog'l Station.	Natural Habitat.
Agrimonia, Tour.,	Agrimony.		
? A. Eupatoria, L.,		Limestone,	Woods and banks.
A. parviflora, Ait.,		"	" "
Sanguisorba, L.,	Great Burnet.		
*S. annua, Nutt.,			Plains of Red River.
Geum, L.,	Avens.		
G. album, Gm.,			Prairies. (M. Cox.)
*G. Virginianum, L,		Limestone,	Damp fertile soil.
*G. vernum,		"	Woods and thickets.
Potentilla, L.,	Cinque foil.		
P. Canadensis, L.,		Cherty,	Dry prairies.
Fragaria, Tour.,	Strawberry.		
F. Virginiana, Ehr.,		Clayey soil,	Woods and prairies.
Rubus, L.,	Bramble.		
R. villosus, Ait.,	High Blackberry,	Alluvial,	Borders of woods and pra.
R. Canadensis, L,	Dewberry,	Sandstone,	Rocky hills and creeks.
R. trivialis, Mich.,	Low Bush-Blackberry,		Dry soil, barren.
R. cuneifolius, Pursh.,	Sand Blackberry,	Sandstone,	Banks.
Rosa, Tourn.,	Rose.		
R. setigera, Mich.,	Prairie Rose,	Limestone,	Banks, prairies, and bott.
R. lucida, Ehr.,	Dwarf Rose,	"	Margin of swamps.
*R. foliosa, Nutt.,			Prairies.
Cratœgus, L.,[1]	Hawthorn.		
Crus-galli, L.,		Limestone,	Thickets and banks.
C. coccinea, L.,	Scarlet Thorn,	"	Thickets. Rocky banks.
C. tomentosa, L.,	Pear Thorn,	"	Woods & swamps. M. Spg.
C. punctata, Jacq.,			Borders of prairies.
C. spathulata, Mich.,		Limestone & sandy,	Prairies. Mam. Springs.
*C. æstivalis, Tor. & Gr.,			Low wet banks.
C. flava, Ait.,	Summer haw,	Sandy,	Prairies.
? C. parvifolia, Ait.,	Dwarf thorn,	"	Dry soil.
Pyrus, L.,	Pear-apple.		
? P. coronaria, L.,[2]	Crab-apple,	Limestone,	Borders of woods.
? P. angustifolia, Ait.[3]			
P. arbutifolia, L.,	Chokeberry,	Sandstone,	Cliffs.
Amelanchier, T. & Gr.,	Juneberry.		
? A. Canadensis, T. & Gr.,	Shad Bush,	Sandstone,	Swampy ground, springs, and dry rocky places.

Calycanthaceæ. *Allspice Family.*

Calycanthus, L.,	Carolina Allspice.		
? C. floridus, L.,[4]		Sandstone,	Rocky hills, &c.

[1] The best species for hedges is Cratægus oxyacantha, L., introduced from Europe.

[2] I did not see this species on our way through Arkansas, but heard that it was in plenty around the Northern prairies.

[3] Resembles the former, and is often confounded with it.

[4] I did not see it in Arkansas, but on the southern limits of Missouri near Arkansas.

Latin Names.	English Names.	Geolog'l Station.	Natural Habitat.
Melastomaceæ.			
Rhexia, L.,	Deer-grass.		
*R. Virginica, L.,		Sandy,	Moist places.
Lythraceæ. *Loosestrife Family.*			
Hypobrichia, Curt.			
*H. Nuttallii, T. & Gr.,			Slow streams, ponds.
Ammannia, Houst.			
*A. latifolia, L.,			Wet places.
Lythrum, L.,	Loosestrife.		
L. alatum, Pursh.,			Wet prairies.
Decodon, Gmel.			
? D. verticillatum, Gm.,			Swamps of Mississ. River.
Cuphea, Jacq.			
C. viscosissima, Jacq.,		Clay,	Roads and wet prairies.
Onagraceæ. *Evening-Primrose Family.*			
Oenothera, L.,	Evening Primrose.		
O. biennis, L.,			Prairies.
*O. rhombipetala, Nutt.,			Plains of Red River.
*O. sinuata, L.,			Fields and grassy places.
*O. speciosa, Nutt.,			Plains of Red River.
O. linifolia, Nutt.,		Sandy,	Prairies.
*O. triloba, Nutt.,			Arid plains of Red River.
*O. serrulata, Nutt.,			" "
Gaura, L.			
G. biennis, L.,		Limestone,	Rocky prairies.
G. filipes, Sp.,		"	" "
*G. sinuata, Nutt.			
*G. villosa, Torr.			
*G. coccinea, Nutt.,			Plains.
*G. parviflora, Doug.			
Stenosiphon, Spach.			
S. virgatus, Sp.,		Magnesian limest.,	Barren.
Jussiæa, L.			
*J. repens, L.,			Ponds.
*J. occidentalis, Nutt.,			Margin of ponds.
*J. leptocarpa, Nutt.,			Ponds and swamps.
Ludwigia, L.,	False Loosestrife.		
L. alternifolia, L.,			Swamps.
L. polycarpa, Sp. & C.,		Clay,	Low prairies.
L. palustris, Ell.,		Limestone,	Along streams.
Proserpinaca, L.,	Mermaid weed.		
P. palustris, L.,			Swamps and ditches.
Myriophyllum, Vat.,	Water Milfoil.		
M. spicatum, L.,			Bayous.
*M. heterophyllum, Mich.,			Ponds and slow streams.
M. scabratum, Mich.,			Mammoth Spring.

LATIN NAMES.	ENGLISH NAMES.	GEOLOG'L STATION.	NATURAL HABITAT.
	Loasaceæ.		
Mentzelia, Plum.			
*M. oligosperma, Nutt.,			Rocky places.
*M. rhombifolia, Nutt.,			Plains of Red River.
	Cactaceæ. *Cactus Family.*		
Opuntia, Tourn.,[1]	Prickly pear.		
O. vulgaris, L.,		Limestone,	Rocks.
O. Missouriensis, Nutt.,			Arid plains.
	Grossulaceæ. *Currant Family.*		
Ribes, L.,	Currant. Gooseberry.		
R. floridum, L.,		Limestone,	Rocky borders of M. Spg.
*R. aureum, Pursh.,		"	Banks of streams.
*R. tenuiflorum, Lind.,		"	" "
	Passifloraceæ. *Passion Flower Family.*		
Passiflora, L.,	Passion flower.		
P. incarnata, L.,		Sand and clay,	Thickets, dry, poor soil.
*P. lutea, L.,		Alluvial,	Thickets, bottoms.
	Cucurbitaceæ. *Gourd Family.*		
Sicyos, L.,	Star Cucumber.		
*S. angulatus, L.,		Sandy,	Banks of rivers.
	Crassulaceæ. *Orpine Family.*		
Sedum, L.	Stone-crop.		
*S. sparsiflorum, Nutt.,			Plains of Red River.
S. ternatum, Mich.,		Limestone,	Rocky banks.
S. pulchellum, Mich.,		"	Humected rocks.
Penthorum, Gron.,	Ditch stone-crop.		
P. sedoides, L.,		Limestone,	Ditches and wet prairies.
	Saxifragaceæ. *Saxifrage Family.*		
Saxifraga, L.,	Saxifrage.		
S. Virginiensis, Mich.,		Sandstone, &c.,	Humected rocks.

[1] The Prickly pear reddens the urine of those who eat it in some quantity. This has been taken as an effusion of blood, but it is only a harmless coloration.

Latin Names.	English Names.	Geolog'l Station.	Natural Habitat.
Heuchera, L.,	Alum root.		
H. Americana, L.,[1]	"	Limestone, &c.,	Prairies.
Hydrangea, Gron.			
H. arborescens, L.,		Sandstone,	Rocky banks.

Hamamelaceæ.

Latin Names.	English Names.	Geolog'l Station.	Natural Habitat.
Hamamelis, L.,	Witch-Hazel.		
H. Virginica, L.,[2]		Limestone,	Rocky banks and woods.
Liquidambar, L.,	Sweet gum.		
L. Styraciflua, L.,[3]		Sandstone,	Alluvial fertile soil.

Umbelliferæ.[4] *Parsley Family.*

Latin Names.	English Names.	Geolog'l Station.	Natural Habitat.
Hydrocotyle, Tour.,	Pennywort.		
H. umbellata, L.,		Limewater,	Mammoth Spring.
? H. ranunculoides, L.,			Borders of streams.
Sanicula, Tourn.,	Black snakeroot.		
S. Marilandica, L.,			Woods and thickets.
Eryngium, Tour.,	Button snakeroot.		
*E. diffusum, Tor.,			Canadian River.
*E. Læveniworthii, T & Gr.,			Plains of Red River.
E. yuccæfolium, Mich.,	Button snakeroot,[5]	Alluvial,	Swamps and bottoms.
E. Virginianum, Lam.,	"	Sandstone,	Rocky open woods.
*E. Baldwinii, Spr.,		Sand,	" " sterile places.
Daucus, Tourn.,	Carrot.		
? D. Carota, L.,[6]			Roadsides.
*D. pusillus, Mich.,			Prairies.
Polytænia, D C.			
? P. Nuttallii, D C.,			Barren.
Pastinaca, Tour.,	Parsnip.		
? P. sativa, L.,			Fields. Introduced.

[1] This plant is generally known under the name of Alum-root. In Arkansas, it grows especially on dry rocky prairies. The whole plant is glandular, hairy, with roundish-lobed leaves from the root, like the scape, bearing a long greenish raceme of small flowers. The pulverized root is used with success in cancerous diseases.

[2] Resembles the true Hazel by its leaves, but easily known by greenish-yellow flowers appearing in the fall and winter. Its branches were used for divining rods. The Indians used its bark as *great medicine*. It has no real medical virtue.

[3] A large and beautiful tree, with compact, fine-grained, but easily decayed wood, used for cabinet-work. The gum which exudes from the tree in summer has a pleasant odor, but no medical properties.

[4] Plants with various properties in different parts. Roots generally eatable and wholesome, like the Carrot. Leaves and stems, as in the Water Hemlock, containing an acrid juice, often very poisonous. Seeds with an aromatic oil, which renders them tonic, stimulating, and aromatic as medicines. The name of the family indicates the disposition of their small white flowers borne on numerous pedicels arranged like the branches of an umbrella.

[5] Plant with long linear leaves about one inch broad, ciliate with soft spines; flowers on a long peduncle, in round green heads. Root bitter, aromatic, highly esteemed in the South as diaphoretic and expectorant.

[6] Sometimes escaped from garden.

LATIN NAMES.	ENGLISH NAMES.	GEOLOG'L STATION.	NATURAL HABITAT.
Archemora, D C.,	Cowbane.		
A. rigida, D C.,[1]			Swamps. Wet meadows.
Tiedmannia, D C.,	False Water Dropwort.		
? T. teretifolia, D C.,[2]			
Cymopterus, Raf.			
*C. glomeratus,			Plains.
Cynosciadium, D C.			
*C. digitatum, D C.,			Wet prairies and ponds.
*C. pinnatum, D C.,			" "
Thaspium, Nutt.,	Meadow Parsnip.		
T. barbinode, Nutt.,		Limestone,	Rocky banks.
Zizia, D C.			
Z. integerrima, D C.,			Rich woods.
Helosciadium, Koch.			
*H. leptophyllum, D C.,		Alluvial,	Banks.
Leptocaulis, Nutt.			
*L. inermis, Nutt.,			Prairies.
*L. diffusus, Nutt.,			"
*L. patens, Nutt.,			"
*L. echinatus, Nutt.			
Cicuta, L.,	Water hemlock.		
? C. maculata, L.,[3]	Spotted Cowbane. Beaver-poison.		Swamps.
Sium, L.,	Water Parsnip.		
S. angustifolium, L.,		Limestone water,	Mammoth Spring.
Chærophyllum, L.,	Chervil.		
C. procumbens, Lam.,			Moist, shady, rich soil.
*C. Tainturieri, Hook & Arn.,			Prairies.
Conium, L,	Poison Hemlock.		
? C. maculatum, L.,[4]			Roadsides. Introduced.
Eulophus, Nutt.			
*E. Americanus, Nutt.,			Prairies.
Atrema, D C.			
*A. Americana, D C.,			Prairies.
Erigenia, Nutt.,	Harbinger of Spring.		
? E. bulbosa, Nutt.,		Alluvial,	Rich shady bottoms.

[1] One of the numerous plants to which milk sickness is attributed. Poisonous to the cattle. Stem smooth. Leaves cut in three lanceolate, scarcely toothed leaflets. Common in swamps and marshy bottoms.

[2] I saw it in Illinois, near the Mississippi River, not far from the limits of Arkansas.

[3] Plant very poisonous. Stem four to six feet high, striate, spotted green and purple. Leaves divided three times, pinnate, divisions small, lanceolate, serrate. Fruit round, laterally contracted, ribbed, with the taste of anise. Habit the marshes. Probably in Arkansas.

[4] A large herb, with smooth spotted stems. Leaves sheathing, large, decompound with small lanceolate leaflets. Fruit ovate, compressed, ribbed. Flowers small, with an involucre of five leaves. A violent poison, narcotic and acrid. I did not see it in Arkansas, but in Illinois. Introduced. Some other species of this family are introduced in gardens: the Parsley, Celery, Dill, Fennel, Caraway, Coriander, &c. Mostly used as condiment and for their aromatic seeds.

Latin Names.	English Names.	Geolog'l Station.	Natural Habitat.
	Araliaceæ. *Ginseng Family.*		
Aralia, L.,			
A. spinosa, L.,	Hercules' club,	Limestone,	River banks (rare).
A. quinquefolia, T. & Gr.,	Ginseng,[1]	Alluvial, &c.,	Rich woods.
	Cornaceæ. *Dogwood Family.*		
Cornus, L.,	Cornel.		
C. florida, L.,[2]	Dogwood,	Sand and lime, &c.	Dry hills, borders of wood.
C. sericea, L.,	Kinnikinnik,	Limestone, &c.,	Banks of streams.
C. stricta, Lam.,	Stiff cornel,	"	Mammoth Spring.
Nyssa, L.,	Tupelo. Sour Gum.		
N. multiflora, Wang.,	Black gum,[3]	Sandstone & chert,	Fertile soil. Hillsides, bks.
N. grandidentata, Mich.,	Large Tupelo,[4]	Alluvial,	Swamps and bayous.
*N. capitata, Walt.,	Ogechee Lime,[5]	"	" "
	Caprifoliaceæ.[6] *Honeysuckle Family.*		
Symphoricarpus, Dill.,	Snowberry.		
S. vulgaris, Mich.,	Indian Currant,	On every formation and situation.	
Lonicera, L.,	Honeysuckle.		
? L. sempervirens, Ait.,			Borders of swamps.
L. albiflora, T. & Gr.,[7]		Limestone,	Banks and prairies.
Triosteum, L.,	Feverwort. Horse Gentian.		
T. perfoliatum, L.,[8]	"	Limestone,	Prairies and rocky banks.
*T. angustifolium, L.,			Shady places.
Sambucus, L.,	Elder.		
S. Canadensis, L.,		Limestone,	Rich soil, thickets.
Viburnum, L.,	Arrow wood.		
V. nudum, L.,	Withe-rod,	Alluvial,	Swamps.
V. prunifolium, L.,	Black haw,	Limestone,	Rocky banks, thickets.
V. dentatum, L.,	Arrow wood,	Alluvial,	Low ground.
? V. acerifolium, L.,	Dock-Mackie,		Woods.

[1] Root aromatic and stimulant. Especially gathered for export to China.

[2] Wood close-grained, used for cabinet-work and wooden wedges. Bark astringent, tonic, febrifuge. The infusion of the flowers is used against colic. The bark of the Kinnikinnik is also febrifuge, often substituted for Cinchona.

[3] Wood firm, close-grained, and not to be split, on account of the crossing of its fibres. Used for wheels or shafts, or such work as requires toughness. It burns slowly and gives much heat.

[4] Abounds in the swamps of Southern Arkansas. A large tree. Wood soft, scarcely used.

[5] The fruit preserved in sugar is said to have a delicious flavor.

[6] Some species have medical properties. The flowers of the Elder are sudorific, and the bark is emetic and purgative. The root of the Feverwort or Horse-Gentian is also purgative, and in strong doses a powerful emetic.

[7] Probably the same as I have seen growing on limestone banks above Carrollton. But the leaves only were left.

[8] Stem hirsute, one to two feet high, with opposite oval-pointed leaves, narrowed at the base. Flowers dull brown, and scarcely remarked in the axil of the leaves. Fruit orange-yellow, resembling the fruit of the Rose.

Latin Names.	English Names.	Geolog'l Station.	Natural Habitat.
	Rubiaceæ.[1] *Madder Family.*		
Galium, L.,	Bedstraw.		
*G. virgatum, Nutt.,			Dry prairies.
G. trifidum, L.,		Alluvial,	Swamps, bottoms.
G. triflorum, Mich,			Woods.
G. pilosum, Ait.,		Sandstone,	Dry rocky woods.
*G. circæzans, Mich.,		Alluvial,	Rich soil, woodland.
G. latifolium. Mich.,		Sandy,	Rocky dry ridges.
Spermacoce, L,	Button weed.		
? S. glabra, L.,		Sand,	Banks.
Diodia, L.			
D. teres, Walt.,		Sandy,	Dry soil, fields, &c.
Cephalanthus, L.,	Button bush.		
C. occidentalis, L.,		Alluvial,	Swamps, wet meadows.
Mitchella, L.,	Partridge berry.		
M. repens, L.,		Limestone,	Mossy, rocky banks.
Oldenlandia, Plum.,	Bluets.		
? O. glomerata, Mich.,[2]		Sandy,	Wet places, roadsides.
O. stenophylla, T. & Gr.,		Limestone.	Rocky open woods.
*O. longifolia, Hook.,			Shady banks.
O. purpurea. T. & Gr.,		Sandstone,	Rocky woods.
? O. cærulea, Hook.,			Prairies.
*O. minima, T. & Gr.,			Banks of rivers.
Metreola, L.,	Mitrewort.		
? M. petiolata, T. & Gr.,			Damp shady soil.
Spigelia, L.,[3]	Worm grass.		
S. Marilandica. L.,	"		Rich woods.
	Valerianaceæ. *Valerian Family.*		
Fedia, Moench.,	Corn salad.[4]		
*F. longiflora, Tor. & Gr.,			Plains.
*F. Nuttallii, T. & Gr.,			"

[1] The Madder, Cinchona, Ipecacuanha, Coffee, &c., belong to this family. The roots generally contain a red coloring matter used in dyeing; the bark has a tonic, astringent, and febrifuge principle, and the seeds of some species have the taste and stimulating property of the Coffee.

[2] I have not seen it in Arkansas, but in Illinois and Missouri, near the limits of Arkansas. It is probably there.

[3] A well-known plant. Flower fine yellow-pink, funnel form. Root vermifuge. Ought to be used with prudence. The root should be gathered in autumn, and carefully dried before packing. It is used in infusion. If too strong, it may kill young children.

[4] The Corn Salad (Fedia olitoria) is cultivated in gardens, and introduced from Europe.

Latin Names.	English Names.	Geolog'l Station.	Natural Habitat.
	Compositæ.[1]		
Veronnia, Schreb.,	Iron weed.		
V. Noveboracensis, Willd.,[2]		On every ground and station.	
*V. Baldwinii, Tour.,			Arkansas River.
V. fasciculata, Mich.,		Limestone,	Gravel of White River.
*V. Jamesii, T. & Gr.,		Sand,	Arkansas River.
*V. Arkanseana, D C.			"
Elephantopus, L.,	Elephant's foot.		
E. Carolinianus, Willd.,		Limestone,	Alluvial bottoms.
*E. tomentosus, L.,			"
Liatris, Schr.,	Button snakeroot.		
L. elegans, Willd.,		Cherty Limestone,	Prairies and barrens.
L. squarrosa, Willd.,	Rattlesnake's master,	"	" "
L. cylindracea, Mich.,		Limestone,	Rocky woods and prairies.
*L. punctata, Hook.,			Arid plains.
L. graminifolia, Willd.,		Sandstone,	Pine barren, North. Arks.
L. spicata, Willd.,			Prairies.
L pycnostachya, T. & Gr.,		Limestone,	High prairies.
L. scariosa, Willd.,[3]	Snakeroot;	"	Rocky barren.
Kuhnia, L.			
K. Eupatorioides,		Limestone,	Barren and prairies.
Eupatorium, Tour.,	Throughwort.		
? E. purpureum, L.,		Alluvial,	Low ground.
? E. coronopifolium, Willd.,			Barren and prairies.
E. hyssopifolium, L.,		Sandstone,	Dry rocky barren.
E. altissimum, L.,		Limestone,	Thickets around prairies.
E. perfoliatum, L.,	Boneset,	Alluvial Lime.,	Swampy and rocky ground,
E. serotinum, Mich.,			Damp soil. [springs.
E. ageratoides, L.,	White Snakeroot,[4]	" "	Borders of rich woodland.
Conoclinum, D C.,	Mist flower.		
C. coelestinum, D C.,	"	Alluvial Lime.,	Rich banks and bottoms.
Sericocarpus, Nees.,	White-topped Aster.		
L. solidagineus, Nees.,		Chert and sand,	Dry rocky woods.
Aster, L.,	Aster. Starwort.		
*A. paludosus, Ait.,			Barren and prairies.
A. sericeus, Vent.,		Limestone,	" "
A. patens, Ait.,		Sandy,	Woods and prairies.

[1] This family contains the greatest number of American plants. It has no remarkable properties. Some species are bitter, tonic, sudorific, and their virtue has been advocated without apparent reason as snake-roots, for curing the bite of snakes. No American tree belongs to this family. It has mostly useless weeds and some fine flowering plants.

[2] Over-credulous people have been induced to believe that the presence of this plant indicates copper in the ground below. It grows everywhere, and on every soil.

[3] The root of this species and *L. squarrosa* is said to possess powerful diuretic properties, and is also used in decoction as a gargle for sore throat. (Darby.) All the Liatris are diuretic.

[4] This species, as well as the Boneset, has been indicated as causing milk sickness. They are entirely harmless plants, which cannot injure the cattle. They contain a bitter, tonic, and febrifuge principle, and are much used as popular medicines. The leaves of the Boneset are united together at the base. Both common plants, with white flowers in umbellate panicles.

Latin Names.	English Names.	Geolog'l Station.	Natural Habitat.
A. lævis, L.,			Dry thickets, open woods.
A. turbinellus, Lind.,		Limestone,	Dry prairies and barren.
A. azureus, Lind.,		Sandstone,	Rocky open woods.
A. undulatus, L.,		"	Dry woodland.
A. cordifolius, L.,		Alluvial Lime.,	Woods.
A. sagittæfolius, Willd.,		Limestone,	Open woods.
? A. ericoides, L.,		Sand,	Barren.
*A. multiflorus, Ait.,		"	" and prairies.
? A. dumosus, L.,			Woods.
? A miser, L.,		Sandy,	Old fields.
A. tenuifolius, L.,		Cherty Limestone,	Open hilly woods.
A. puniceus, L.,		Limestone,	Prairies and barren.
? A. prenanthoides, Muhl.,		Alluvial,	Banks and woods.
A. grandiflorus, L.,		Limestone,	Rocks and banks.
*A. oblongifolius, Nutt.,			Dry prairies.
*A. divaricatus, Nutt.,			Swamps & saline prairies.
Erigeron, L.,	Fleabane.		
E. Canadense, L.,		Clay, &c.,	Dry open places.
*E. divaricatum, Mich.,		"	" "
? E. Philadelphicum, L.,	Fleabane,[1]		Woodland and fields.
*E. tenue, T. & Gr.,			Prairies & banks of rivers.
E. annuum, Pers.,	Daisy fleabane,		Fields and prairies.
? E. strigosum, Muhl.,	D.		Open places.
Diplopappus, Cass.,	Double-bristled Aster.		
D. linearifolius, Hook.,		Sandstone,	Top of rocky hills.
*D. amygdalinus, T. & Gr.,			Moist places.
Chætopappa, D C.			
*C. asteroides, D C.,			Prairies.
Boltonia, L'Her.			
? B. glastifolia, L'Her.,			Wet woods and swamps.
Bellis, L.,	Daisy.		
B. integrifolia, Mich.,		Limestone,	Banks of streams (M. Cox).
Amphiachyris, D C.			
*A. dracunculoides, D C.,			Western Arkansas.
Gutierrezia, Lag.			
*G. Texana, T. & Gr.,			Prairies.
Solidago, L.,	Golden rod.		
S. squarrosa, Muhl.,		Limestone,	Rocky ridges.
S. bicolor, L.,			Open woods, dry places.
S. pubens, ? Curt.,[2]		Limestone,	Woody hills on rocks.
S. cæsia, L.,		Sandy,	Woods and hills.
*S. angusta, T. & Gr.,		Lime, ?	Hot springs.
S. petiolaris, Ait.,		Sandstone,	Dry open woods & prairies.
S. speciosa, Nutt.,		Sandy,	Prairies (rare).
S. rigida, L.,		"	Prairies (common).
S. corymbosa, Ell.,			"

[1] Has sudorific and diuretic properties.
[2] Perhaps a variety of Solidago bicolor. Leaves broader and strongly ciliate.
[3] Differs by its very rough stem.

Latin Names.	English Names.	Geolog'l Station.	Natural Habitat.
S. altissima var. aspera.,	. . . .	. . . . .	Thickets and old fields.
S. ulmifolia, ? Muhl.,	. . . . .	Limestone,	Rocky ridges.
S. Drummondii, T. & Gr.,	. . . .	. . . . .	Prairies.
S. pilosa, Walt.,	. . . . .	Sand,	Dry prairies.
S. odora, Ait.,[1]	. . . . .	Sandstone,	Thickets and rocky woods.
S. Boottii, Hook.,	. . . . .	"	" "
S. nemoralis, Ait,	. . . . .	. . . . .	Rocky hills.
S. radula, Nutt.,	. . . . .	Sandstone,	Rocky ridges.
*S. scaberrima ? T. & Gr.,	. . . .	. . . . .	Dry prairies.
*S. Missouriensis, Nutt.,	. . . .	. . . . .	" "
S. Canadensis, L.,	. . . . .	Cherty,	Rocky barren.
S. gigantea, Ait.,	. . . . .	. . . . .	Thickets.
S. lanceolata, L.,	. . . . .	. . . . .	Prairies.
S. tenuifolia, Pursh.,	. . . . .	Sand,	Dry prairies.
Prionopsis, Nutt.			
*P. ciliata, Nutt.,	. . . . .	Alluvial,	Banks of Salt River.
Grindelia, Willd.			
*G. Inuloides, Willd.			
G. lanceolata, Nutt.,	. . . . .	Magn. limestone,	Barrens.
Chrysopsis, Nutt.,	Golden Aster.		
? C. Mariana, Nutt.,	. . . . .	Sand,	Barren.
? C. villosa, Nutt.,	. . . . .	. . . . .	Prairies.
*C. pilosa, Nutt.,	. . . . .	Sandstone,	Pine woods. Open barren.
Baccharis, L.,	Groundsel-tree.		
*B. salicina, T. & Gr.,	. . . . .	. . . . .	Banks of Arkansas River.
Pluchea, Cass.,	Marsh Fleabane.		
P. foetida, D C.,	. . . . .	Alluvial,	Damp rich soil.
Diaperia, Nutt.			
*D. prolifera,	. . . . .	. . . . .	Banks of Red River.
Inula, L.,	Elecampane.		
I. Helenium, L.,[2]	. . . . .	. . . . .	Woods and thickets. Introduced?
Polymnia, L.,	Leaf cup.		
P. Canadensis, L.,	. . . . .	Limestone,	Hillsides. Shady places.
P. Uvedalia, L.,	. . . . .	Alluvial,	Rich soil, fernes.
Chrysogonum, L.			
? C. Virginianum, L.,	. . . . .	. . . . .	Dry soil, prairies.
Sylphium, L.,	Rosin plant.		
S. laciniatum, L.,	Rosin weed,	Limestone,	Prairies.
S. terebinthinaceum, L.,	Prairie dock,	. . . . .	"
S. trifoliatum, L.,	. . . . .	. . . . .	Prairies and thickets.
S. scaberrimum, Ell.,	. . . . .	. . . . .	Prairies.
S. integrifolium, Mich.,	. . . . .	Limestone,	Barrens.
Berlandiera, D C.			
*B. Texana, D C.,	. . . . .	. . . . .	Woods.
B. tomentosa, T. & Gr.,	. . . . .	Sandy,	Dry Pine barrens.
? B. incisa, T. & Gr.,	. . . . .	. . . . .	On the Arkansas or Plate?

[1] The leaves are infused in vinegar to give it a pleasant and aromatic taste.
[2] It is common enough on the rocky borders of woods, and looks indigenous.

Latin Names.	English Names.	Geolog'l Station.	Natural Habitat.
Engelmannia, T. & Gr.			
E. pinnatifida, T. & Gr.,			Red River plains.
Parthenium, L.			
P. integrifolium, L.			Dry prairies.
Iva, L.,	Marsh Elder.		
*I. ciliata, Willd.,			Swamps and moist places.
*I. angustifolia, Nutt.,			Prairies.
Ambrosia, Tour.,	Ragweed.		
A. bidentata, Mich.,		Sandy,	Roadsides and prairies.
A. artemisiæfolia, L.,			Prairies.
A. trifida, L.,		Alluvial,	Bottoms.
A. polystachia, D C.,		Limestone,	Barren and prairies.
Xanthium, Tour.,	Cockleburr.		
X. strumarium, L.,			Cultivated fields.
Zinnia, L.			
Z. multiflora, L.,[1]		Limestone,	Prairies.
Tetragonotheca, Dill.			
T. helianthoides, L.,		Sandstone,	Open hilly woods (rare).
Eclipta, L.			
? E. procumbens, Mich.,		Alluvial,	Wet banks of rivers.
Heliopsis, Pers.,	Ox-eye.		
H. lævis, Pers. and *var.* Scabra,			Dry soil, prairies, &c.
Echinacea, Mönch.,	Purple cone-flower.		
E. purpurea, M.,			Prairies (common).
*E. angustifolia, D C.,			"
*E. atrorubens, Nutt.,			Plains.
Rudbeckia, L.,	Cone flower.		
*R. bicolor, Nutt.,			Red River, plains.
R. hirta, L.,		Sandy,	Dry prairies.
R. fulgida, Ait.,			Prairies and barrens.
? R. speciosa, Wend.,		Sandstone,	Rocky, open barrens.
R. triloba, L.,			Dry prairies.
R. subtomentosa, Pursh.,			Prairies.
*R. grandiflora, Gmel.,			Plains of Red River.
R. laciniata, L.,			Wet places. Thickets.
*R. maxima, Nutt.,			Plains, Red River.
Dracopsis, Cass.			
*D. amplexicaulis, Cass.,			Low prairies.
Helianthus, L.,	Sun-flower.		
*H. lenticularis, Dougl.,			Prairies.
*H. petiolaris, Nutt.,			Arid plains.
*H. orgyalis, D C.,			" "
*H. atrorubens, L.,			Dry soil.
H. rigidus, Desf.,			Prairies.
H. lætiflorus, Pers.,			Barrens and prairies.
H. occidentalis, Rid.,			Dry prairies.
H. mollis, Lam.,		Cherty limestone,	Barrens.

[1] Abounds on the prairies of Benton County, and certainly indigenous. Species cultivated in our gardens.

Latin Names.	English Names.	Geolog'l Station.	Natural Habitat.
*H. grosse-serratus, Mart.,			Dry plains.
H. tomentosus, Mich.,		Red upland,	Prairies and open places.
? H. doronicoides, Lam.,		Alluvial,	Bottoms.
*H. strumosus, L.,			Copses and banks of rivers.
*H. hirsutus, Raf.,			Dry prairies.
Actinomeris, Nutt.			
A. squarrosa, Nutt.		Limestone,	Banks and bottoms.
A. helianthoides, Nutt.,			Thickets and bottoms.
Coreopsis, L.,	Tickseed.		
*C. involucrata, Nutt.			
? C. tripteris, L.,			Banks of rivers.
C. verticillata, L.,			Moist places, prairies.
*C. palmata, Nutt.,		Limestone,	Banks and prairies.
C. lanceolata, L.,			Prairies.
*C. grandiflora, Nutt.,			Plains.
*C. tinctoria, Nutt.,			Damp prairies.
Cosmidium, Tor. & Gr.			
*C. filifolium, T. & Gr.,			Plains of Red River.
Bidens, L.,	Bur-Marigold.		
B. cernua, L.,	"	Limestone,	Springs.
B. chrysanthemoides, Mich.,		Alluvial,	Swampy bottoms.
B. bipinnata, L.,	Spanish Needles,	Limestone,	Banks and dry soil.
Spilanthes, Sar.			
*S. Nuttallii, T. & Gr.,			Inundated places.
Verbesina, L.,	Crownbeard.		
? V. Siegesbeckia, Mich.,			Banks and roadsides.
V. Virginica, L.,			Woods and dry soil.
Dysodia, D C.			
*D. tagetoides, T. & Gr.			
D. chrysanthemoides, Lag.,			Banks of rivers & prairies.
Gaillardia, D C.			
*G. lanceolata, Mich.,			Barrens.
*G. pinnatifida, Tor.,			Plains.
*G. pulchella, Tor.,			Prairies.
Palafoxia, Lag.			
*P. Hookeriana, T. & Gr.			
P. callosa, T. & Gr.,		Limestone,	Barrens.
Hymenopappus, L'Her.			
*H. corymbosus, T. & Gr.,			Prairies.
Helenium, L.,	False Sunflower.		
H. autumnale, L.,		Alluvial,	Wet soil, prairies, &c.
*H. tenuifolium, Nutt.,			Fields and roadsides.
*H. quadridentatum, Lab.,			Banks of rivers.
? H. microcephalum, D C.,			Texas or Arkansas?
Leptopoda, Nutt.			
L. brachypoda, T. & Gr.,			Damp prairies.
Marshallia, Schreb.			
*M. cæspitosa, Nutt.,			Prairies.
M. latifolia, Pursh.,		Limestone,	Barrens.
Maruta, Cass.,	Mayweed.		
M. cotula, D C.,		Sandy,	Dry fields. Introduced.

Latin Names.	English Names.	Geolog'l Station.	Natural Habitat.
Achillæa, L.,	Yarrow.		
A. millefolium, L.,[1]	Milfoil,	Sandy,	Roadsides and open places.
Egletes, Cass.			
*E. Arkansana, Nutt.			
Artemisia, L.,	Wormwood.		
? A. dracunculoides, Pursh.			
*A. Lewisii, T. & Gr.,			Plains and banks.
? A. biennis, Willd.,		Alluvial,	Sandy banks Miss. River.
Gnaphalium, L.,	Cudweed.		
G. decurrens, Ives.,	Everlasting,	Sandy,	Woods.
G. polycephalum, Mich.,		Sandstone,	Rocky barren.
Erechtites, Raf.,	Fireweed.		
E. hieracifolia, Raf.,	"		Clearings on charcoal.
Cacalia, L.,	Indian plantain.		
? C. reniformis, Muhl.,		Alluvial,	Rich bottoms.
C. atriplicifolia, L.,		Limestone,	Wet prairies.
C. tuberosa, Nutt.,		"	"
Senecio, L.,	Groundsel.		
S. aäreus, L.,	Squaw-weed,		Swampy bottoms & banks.
Centaurea, L.,	Star thistle.		
*C. Americana, Nutt.,			Western Arkansas.
Cirsium, Tour.,	Plumed thistle.		
C. altissimum, Spreng.,		Alluvial,	Rich soil. Thickets.
C. discolor, Spreng.,		Limestone,	Fields and thickets.
C. Virginianum, Mich.,		Sandstone,	Woods and barrens.
? C. horridulum, Mich.,			Hills. Poor soil.
Lappa, Tour.,[2]	Burdock.		
L. major, Gært.,			Around dwellings.
Apogon, Ell.			
*A. humilis, Ell.			
Krigia, Schreb.,	Dwarf Dandelion.		
*K. Occidentalis, Nutt.			
? K. Virginica,		Sandy,	Moist gronnd.
Cynthia, Don.			
? C. Virginica, Don.,		"	"
*C. Dandelion, D C.,			Low ground and fields.
Hieracium, Tour.,	Hawk-weed.		
H. scabrum, Mich.,		Sandstone,	Rocky woody places.
H. longipilum, Tor.,		"	Dry prairies.
*H. Gronovii, L.,		"	Sterile prairies.
Nabalus, Cass.,	Rattlesnake-Root.		
N. albus, Hook.,	White Lettuce,	Limestone,	Rocky thickets.
N. altissimus, Hook.,		"	Rocky open woods and thickets.
? N. Fraseri, D C.,	Lion's foot,	Sandy,	Dry soil.

[1] Has some tonic and aromatic properties. Leaves employed for cicatrizing wounds, either by decoction as tea for internal lesions, or by application of masticated leaves on the wounds. It is said to be an active remedy in cases of Intermittent fevers, and also against the Piles. It was once much employed and its value praised for a number of diseases.

[2] Everybody knows this plant, which sometimes becomes a pest around dwellings. It is bitter. The leaves, according to Dr. Darlington, are used as external application in fevers, headache, &c.

Latin Names.	English Names.	Geolog'l Station.	Natural Habitat.
N. virgatus, D C.,		Sandy,	Barren and rocky prairies.
N. asper, T. & Gr.,			Dry prairies.
Taraxacum, Hall.,[1]	Dandelion.		
T. Dens-leonis, Desf.,			Fields. Introduced.
Pyrrhopappus, D C.,	False Dandelion.		
*P. Carolinianus, D. C.,			Fields.
*P. grandiflorus, Nutt.,			Shaded ravines.
Lactuca, Tour.,	Lettuce.		
L. elongata, Muhl.,			Rich fields, fences.
Mulgedium, Cass.,	Blue Lettuce.		
M. Floridanum, D C.,			Borders of fields & thickets.

Lobeliaceæ. *Lobelia Family.*

Lobelia, L.,	Lobelia.		
L. cardinalis, L.,[2]	Cardinal flower,	Limestone,	Low ground, rich bottoms
L. syphilitica, L.,[3]	Great Lobelia,	"	Banks. Hot springs.
? L. leptostachys, D C.,[4]		Sand,	Banks. Mississippi River
? L. amœna, Mich.,			Swamps.
L. inflata, L.,[5]	Indian tobacco,		Dry open soil.
L. spicata, Lam.,			" "

Campanulaceæ.

Campanula, Tour.,	Bell flower.		
C. Americana, L.,		Limestone,	Shaded banks and rich woods.
Specularia, Heist.			
S. perfoliata, D C.,		Sand,	Dry open fields.

Ericaceæ.[6] *Heath Family.*

Gaylussacia, H. B. K.,	Huckleberry.		
G. frondosa, T. & Gr.,	Dangleberry,		Low ground.
? G. dumosa, T. & Gr.,	Dwarf Huckleberry,	Sandstone,	Barrens.
G. resinosa, T. & Gr.,	Black Huckleberry,	"	Rocky hills, open woods.
Vaccinium, L.,	Cranberry, Blueberry.		
V. stamineum, L.,	Deerberry,	Sandstone,	Hilly open woods.

[1] Its milky sap is bitter. The stems, like the root, are used for purifying the blood in the spring. The stalk of the flower is eaten raw for that purpose. The boiled leaves make excellent and wholesome *greens*.

[2] A beautiful flower known by everybody, and often cultivated. The Indians use the root as vermifuge.

[3] Taken in small dose, its root acts as sudorific. A stronger dose acts as purgative, and still a stronger as emetic. It has a beautiful raceme of blue flowers.

[4] Was not found in Arkansas, but near its northern limits. Probably descends further south.

[5] A virulent poison, and dangerous quack medicine.

[6] Shrubby plants. Bark and leaves astringent and tonic. Fruit sometimes acid and eatable with still more astringency, and thus febrifuge and very wholesome. The leaves of some species are used as a substitute for tea. The leaves of other species are used as a remedy against the gravel. Some species have poisonous leaves.

Latin Names.	English Names.	Geolog'l Station.	Natural Habitat.
V. arboreum, Mich.,	Fackleberry,	Sandstone,	Rocky woods and banks.
V. corymbosum, L.,	Swamp blueberry,	Alluvial,	Margin of swamps.
Epigæa, L.,	Ground Laurel.		
E. repens, L.,		Sandstone,	Shady, mossy banks.
Gaultheria, Kal.,	Aromatic Wintergreen.		
G. procumbens, L.,[1]	"	Sandstone,	Cool, damp woods & hills.
Leucothoë, Don.			
L. axillaris, Don?		Sandstone,	Banks of streams.
? L. Catesbæi, Gray,		"	Top of hills, barren.
Andromeda, L.			
? A. Ligustrina, Muhl.,		Sandy,	Borders of swamps.
Oxydendron, D C.,	Sorrel-tree.		
O. arboreum, L.,		Sandstone,	Rocky woods.
Clethra, L.,	Sweet Pepperbush.		
? C. alnifolia, L.,			Swamps.
Kalmia, L.,	American laurel.		
K. latifolia, L.,[2]	Calico-bush,	Sandstone,	Rocky banks (rare).
Rhododendron, L.,	Rose-bay.		
R. maximum, L.,[3]	Great laurel,	"	"
Azalea, L.,	False Honeysuckle.		
A. viscosa, L.,			Swamps.
A. nudiflora, L.,			"
Chimaphila, Pursh.,	Pipsissewa.		
? C. umbellata, Nutt.,[4]	"	Sandy,	Woods.
C. maculata, Pursh.,	Spotted Wintergreen,	"	Rocky woods.
Monotropa, L.,	Indian pipe.		
? M. uniflora, L.,	"		Rich woods.
? M. hypopitys, L.,	Pine sap,		Oak and pine woods.

Aquifoliaceæ.[5] *Holly Family.*

Ilex, L.,	Holly.		
I. opaca, Ait.,	"	Sandstone,	Hills and alluvial bottoms.
I. Cassine, L.,[6]	Yaupon,	Limestone tufa,	Hot Springs.
I. decidua, Walt.,		"	Banks and borders of prairies.
I. verticillata, Gr.,	Black alder,	"	Rocky banks.

[1] The leaves have a pleasant aromatic taste, and are used for tea. Somewhat narcotic. Berries eatable.

[2] The decoction of the leaves of this species is poisonous. It is an evergreen smooth shrub, with elliptical pointed, shining leaves, and with wheel-shaped showy flowers in corymbs or umbels. Leaves and flower smaller than in the next species.

[3] I have not seen the flowers, and it may be another species of the same genus. The infusion of the leaves is given in cases of chronic rheumatism, though the leaves are said by some to be poisonous.

[4] The *herbe a pisser* of the Canadians. This plant and the following were both used as great medicines by the Indians, especially in cases of Scrofula and Rheumatism. They are diuretic plants, used with success in case of gravel in the bladder. Small evergreen. The last with dark-green, lanceolate, oval-pointed, dentate leaves, marked with white along the veins.

[5] The berries of plants of this family are acrid, purgative, and emetic.

[6] Leaves used for tea, the celebrated black drink of the North Carolinian Indians. (Gray.)

Latin Names.	English Names.	Geolog'l Station.	Natural Habitat.
Styracaceæ.	*Storax Family.*		
Styrax, Tour.,	Storax.		
*S. grandifolia, Ait.,			Rich woods.
? S. Americana, Lam.,			Margin of swamps.
Symplocos, Jacq.,	Sweet leaf.		
S. tinctoria, L'Her.,[1]	"	Alluvial,	Swamps.
Ebenaceæ.	*Ebony Family.*		
Diospyros, L.,[2]	Persimmon.		
D. Virginiana, L.,	"	Limestone, &c.,	Barren and rich soil.
Bumelia, Sw.			
*B. lycioides, Ga.,		Alluvial,	Moist bottoms
B. lanuginosa, Pers.,		Limestone,	Rocky bar'ns along creeks.
*B. oblongifolia, Nutt.,		Alluvial,	Woods.
Plantaginaceæ.	*Plantain Family.*		
Plantago, L.,	Plantain. Ribgrass.		
P. major, L.,			Moist fertile soil.
*P. heterophylla, Nutt.,			Arkansas River.
P. aristata, Mich.,		Sandy.	Prairies, dry places.
P. virginica, L.,		Sand,	Prairies, open places.
*P. pusilla, Nutt.,		Sandstone,	Dry hills.
*P. squarrosa, Nutt.,		Sandy,	Prairies near Fort Smith.
Primulaceæ.	*Primrose Family.*		
Androsace, Tour.			
*A. Occidentalis, Pursh.,			Banks of rivers.
Dodecatheon, L.,	American Cowslip.		
D. Meadia, L.,		Limestone, &c.,	Rich woods and wet prairies.
Lysimachia, L.,	Loosestrife.		
L. ciliata, L.,			Wet prairies, low ground.
L. lanceolata, Walt.,			Low ground (M. Cox).
Anagallis, L.,	Pimpernel.		
*A. arvensis, L.,			Cultivated fields.
Centunculus, L.,	Chaffweed.		
*C. minimus, L.,			Low ground.
Samolus, L.,	Brookweed.		
S. Valerandi, L.,		Sandy,	Springs, banks, &c.
Lentibulaceæ.	*Bladderwort Family.*		
Utricularia, L.,	Bladderwort.		
*U. vulgaris, L.,			Ponds and bayous.

[1] Leaves sweet, greedily eaten by cattle. Abundant in the bottoms of South Arkansas.

[2] Very common in Arkansas, where it grows of a good size in a good soil. Wood greenish, hard, compact, but liable to split. Bark bitter and tonic, used as a remedy in cases of intermittent fevers.

Bignoniaceæ.

Latin Names.	English Names.	Geolog'l Station.	Natural Habitat.
Bignonia, Tour.			
B. capreolata, L.,			Climbing. Rich bottoms.
Tecoma, Juss.,	Trumpet flower.		
T. radicans, L.,	"		Rich soil. Climbing.
Catalpa, Scop.,	Indian bean.		
C. Bignonioides, Walt.,[1]	"	Limestone,	Creeks and rocky banks.

Orobanchaceæ. *Broom-rape Family.*

Latin Names.	English Names.	Geolog'l Station.	Natural Habitat.
Aphyllon, Mich.,	Broom-rape.		
*A. uniflorum, T. & Gr.,			Woods.

Scrophulariaceæ. *Figwort Family.*

Latin Names.	English Names.	Geolog'l Station.	Natural Habitat.
Verbascum, L.,	Mullen.		
V. thapsus, L.,[2]	"	Sandy,	Dry open fields.
V. blattaria, L.,	"	"	Prairies.
Linaria, Tour.,	Toad flax.		
*L. Canadensis, Sp.		Sandy,	Prairies.
Scrophularia, Tour.,	Figwort.		
S. nodosa, L.,		Limestone,	Banks & borders of fields.
Collinsonia, Nutt.			
*C. violacea, Nutt.,			Woods.
Chelone, Tour.,	Turtlehead.		
C. glabra, L.,	"		Wet prairies.
Penstemon, Mit.,	Beard tongue.		
P. pubescens, Sol.,		Limestone,	Banks and rocky prairies.
*P. digitalis, Nutt.,			Woods. Dry soil.
*P. tubæflorum, Nutt.,			Prairies.
*P. Cobæa, Nutt.,		Limestone,	Red River.
Conobea, Aub.			
*C. multifida, Benth.,		Sand,	River banks.
Mimulus, L.,	Monkey flower.		
M. alatus, Ait.,		Limestone,	Border of shallow creeks.
Herpestis, Gaert.			
H. rotundifolia, Pursh.,			Muddy ditches.
*H. Brownei, Steud.,			Banks of Mississippi.
H. nigrescens, Benth.,		Limestone, &c.,	Rocky, sandy places. Hot [Springs.
Gratiola, L.,	Hedge-Hyssop.		
*G. Virginiana, L.,			Wet places, ditches.
*G. pilosa, Mich.,			Low ground.
*G. acuminata, Ell.,			" "

[1] This well-known tree bears large heart-shaped leaves, bunches of large white flowers, and seeds in long pendant beans. Though it is not common in Arkansas, it is found abundant enough along the limestone creeks on the western limits of Benton County, where it appears indigenous. Various properties have been ascribed to its bark. But they are not ascertained. The wood is light and durable, resembling the wood of the sycamore. It is not much used.

[2] Flowers used as tea; emollient in pulmonary diseases.

Latin Names.	English Names.	Geolog'l Station.	Natural Habitat.
Ilysanthes, Raf.			
I. gratioloides, Benth.,	False Pimpernel.	Limestone,	Gravel of rivers.
Veronica, L.,	Speedwell.		
V. Virginica, L.,		"	Prairies and barren.
V. Americana, Schw.,		"	Springs. Mammoth Spring.
*V. peregrina, L.,			Cultivated fields.
Buchnera, L.,	Blue Hearts.		
B. Americana, L.,			Prairies. Wet places.
Seymeria, Pursh.			
S. macrophylla, Nutt.,			Gravel. White River.
Gerardia, L.			
G. purpurea, L.,		Sandstone,	Rocky woods and prairies.
*G. longifolia, Nutt.,		Sandy,	Banks of Arkansas River.
G. aspera, Doug.,		Limestone,	Gravel of Mammoth Sp'g.
*G. heterophylla, Nutt.,			Prairies.
G. flava, L.,		Sandst. and chert,	Hilly, rocky open woods.
G. quercifolia, Pursh.,		Sandstone,	Rocky woods.
G. integrifolia, Gray,		"	" "
*G. pedicularia, L.,			Dry copses.
*G. auriculata, Mich.,			Low ground.
Castilleja, L.,	Painted cup.		
C. coccinea, Sp.,			Prairies.
*C. purpurea, Nutt.,			Rocks. Red River.
Pedicularis, Tour.,	Lousewort.		
P. Canadensis, L.,			Prairies. Wet places.
Melampyrum, Tour.,	Cow-Wheat.		
*M. Americanum, Mich.,			Open woods.
Gelsemium, Juss.,	Yellow Jessamine.		
G. sempervirens, Ait.,		Alluvial,	Rich bottoms. Climbing.

Acanthaceæ.

Dianthera, Gron.,	Water Willow.		
D. Americana, L.,			Border of streams.
Dipteracanthus, Nees.			
D. strepens, Nees.,			Dry sandy soil.
D. ciliosus, Nees.,		Sandy,	Prairies.
*D. humilis, Nutt.,			Rocks and prairies.
Dicliptera, Wahl.			
*D. resupinata, Wahl.			

Verbenaceæ. *Vervain Family.*

Verbena, L.,	Vervain.		
V. hastata, L.,			Waste fertile ground.
V. urticæfolia, L.,			Old fields. Roadsides.
V. stricta, Vent.,		Sandstone,	Barrens and rocky creeks.
V. bracteosa, Mich.,		Limestone,	Rocky ridges.
V. Aubletia, L.,		"	Rocky places and prairies.
*V. Caroliniana, Mich.,			Dry soil.
*V. rugosa, Willd.,			" " "
*V. bipinnatifida, Nutt.,			Open hills. Red River.
Lippia, L.			
*L lanceolata, Mich.,			River banks.

Latin Names.	English Names.	Geolog'l Station.	Natural Habitat.
Callicarpa, L.			
C. Americana, L.,[1]	French Mulberry,	Sandstone & Tufa,	Rocky places.
Phryma, L.,	Lopseed.		
*P. leptostachya, L.,		Limestone,	Copses and banks.

Labiatæ.[2] *Mint Family.*

Teucrium, L.,	Germander.		
*T. Canadense, L,	Woodsage,		Low grounds.
Trichostema, L.,	Blue Curls.		
T. dichotomum, L.,	Bastard Pennyroyal,	Chert,	Sandy, open woods.
*T. lineare, Nutt.,		Sandstone,	Rocky, open ground.
Isanthus, Mich.,	False Pennyroyal.		
I. cæruleus, Mich.,		Limestone,	Banks of Miss. River, in [Missouri.
Mentha, L.,	Mint.		
M. viridis, L.,[3]	Spear-mint,	Limestone,	Springs. Mammoth Spg.
*M. Canadensis, L.,	Wild mint,		Wet banks. Brooks.
Lycopus, L.,	Water Horehound.		
*L. Virginicus, L,			Shady moist places.
*L. Europæus, L.,			" "
L. sinuatus, L.,			Wet ground.
Cunila, L.,	Dittany.		
C. Mariana, L.,	"	Sandstone,	Rocky hills.
Pycnanthemum, Mich.,	Basil.		
P. incanum, Mich.,		Cherty limestone,	Rocky woods.
P. clinopodioides, T. & Gr.,			Dry prairies and woods.
P. pilosum, Nutt.,			Hillsides, prairies.
P. muticum, Pers.,		Sandstone,	Dry open woods.
P. lanceolatum, Pursh.,		"	Rocky woods and prairies.
P. linifolium, Pursh.,		Limestone,	High prairies. Mammoth [Spring.
Origanum, L.,	Wild Marjoram.		
*O. vulgare, L.,			Introduced.
Calamintha, Moench.,	Basil.		
*C. nepeta, Link.,		Sandstone,	Dry hills. (Introduced.)
C. Nuttallii, Bent.,		Limestone,	Rocks.
*C. clinopodium, Benth.,			Thickets. (Introduced.)
Melissa, L.,	Balm.		
M. officinalis, L.,[4]			Cultivated. From Europe.
Hedeoma, Pers.,	Pennyroyal.		
H. pulegioides, Pers.,		Sandy,	Dry places.

[1] Fruit beautiful and eatable.

[2] The most natural family of plants either by its form or by its properties. All the plants of the Mint family have tonic, cordial, invigorating properties. They contain apparently two principles, the one bitter, stomachic, and febrifuge, the other aromatic, stimulating, and excitant. Plants of this family are used for condiments, like the sage, or for medical preparations. They are easily known by the aromatic odor that is exhaled by bruising their leaves.

[3] Said to have been introduced to the Mammoth Spring by Indians. This species give the oil of Peppermint of the shops, generally known as a valuable family medicine, and used against Colic, Diarrhœa, Dysentery, Cholera, Nausea, &c. &c.

[4] Has the same properties as the Mint.

Latin Names.	English Names.	Geolog'l Station.	Natural Habitat.
*H. hispida, Pursh.			
*H. Arkanseana, Nutt.,			Sources of Ramiesha Riv.
Collinsonia, L.,	Horse-balm.		
C. Canadensis, L.,			Rich moist woods.
Salvia, L.,[1]	Sage.		
S. lyrata, L.,		Limestone?	Hot springs, on tufa.
S. azurea, Lam.,		"	Rocks and rocky places.
*S. longifolia, Nutt.,			Prairies.
*S. Claytoni, Ell.,			Dry meadows and prairies.
Monarda, L.,	Horse Mint.		
M. fistulosa, L.,	Wild Bergamot,	Limestone,	Prairies and barren.
M. Bradburiana, Beck.,		Sandstone,	Rocky woods and prairies.
M. punctata, L.,			Prairies. Fort Smith.
*M. Russeliana, Nutt.,			" "
*M. aristata, Nutt.,			Red River plains.
Blephilia, Raf.			
B. ciliata, Raf.,			Rich soil. Fences, &c.
Lophanthus, Benth.,	Giant Hyssop.		
*L. nepetoides, Benth.,			Borders of wood.
*L. scrophulariæfolius, Benth.,			" "
Nepeta, L.,	Cat Mint.		
N. Cataria, L.,	Catnip,	Limestone,	Rocky places around farms.
N. glechoma, Benth.,[2]	Ground Ivy, Gil.,	Charcoal,	New clearings, fences, &c.
Dracocephalum, L.,	Dragon-head.		
*D. intermedium, Nutt.,			Prairies.
Synandra, Nutt.			
? S. grandiflora, Nutt.,			Shady banks. Rich soil.
Physostegia, Benth.,	False Dragon-head.		
P. Virginiana, Benth.,			Marshy prairies.
Brunella, Tour.			
B. vulgaris, L.,		Limestone,	Rocky places and prairies.
Scutellaria, L.,	Skull-cap.		
S. versicolor, Nutt.,			River banks and woods.
S. canescens, Nutt.,			Borders of prairies.
*S. parvula, Mich.,		Limestone,	Dry banks and rocks.
S. nervosa, Pursh.,		"	Rocky woods.
S. lateriflora, L.,			Mammoth Spring.
S. resinosa, Tor.,		Limestone,	Barren.
Marrubium, L.,[3]	Horehound.		
*M. vulgare, L.,		Around dwellings,	Wet places. (Introduced.)
Stachys, L.			
*S. aspera, Mich.,			Wet ground.

[1] The garden sage, a native of South France, is tonic, stomachic, and anti-hysteric.

[2] A common species, introduced from Europe. It appears everywhere on the burnt ground of the clearings. It has been commended as a valuable remedy in infusion of leaves and flowers against asthma; even in cases of consumption. Some assert that the plant eaten by horses causes them to become broken winded. Homœopathy would explain easily (similia similibus curantur) these contradictory properties.

[3] Like the Ground-Ivy, used in decoction in cases of consumption or of prolonged coughs and difficult expectoration.

Latin Names.	English Names.	Geolog'l Station.	Natural Habitat.
*S. hyssopifolia, Mich.,		Sandy,	Wet places.
Lamium, L.,	Dead Nettle.		
*L. amplexicaule, L.,			A weed in gardens. (Introduced.)

Borraginaceæ.[1] *Borage Family.*

Onosmodium, Mich.,	False Gromwell.		
O. Virginianum, D C.,		Sandstone,	Dry prairies, rocky woods.
Lithospermum, Tour.,	Gromwell.		
*L. arvense, L.,		Sand,	Banks and roadsides.
*L. tenellum, Nutt.,			Plains of Red River.
? L. angustifolium, Mich.,			River banks.
L. hirtum, Leh.,		Limestone,	Banks and prairies.
*L. canescens, Leh.,			Open woods.
*L. longiflorum, Spreng.,			Prairies and plains.
Mertensia, Roth.,	Lungwort.		
M. Virginica, D C,	"	Alluvial,	Rich soil. Banks.
Myosotis, L.,	Forget-me-not.		
*M. verna, Nutt.,		Sandy,	Dry hills.
Echinospermum, Sw.,	Stick-seed.		
E. lappula, Leh.,		Alluvial,	Woods, waste places, &c.
Cynoglossum, Tour.,	Hounds-tongue.		
*C. officinale, L.,			Waste ground. Pastures.
C. Virginicum, L.,[2]	Wild Comfrey,	Sandstone,	Woods and hills.
Heliotropium, Tour.			
*H. Curassavicum, L.,		Sand,	Banks of Mississippi R.
H. Indicum, L.,			" " "
Euploca, Nutt.			
*E. convolvulacea, Nutt.,		Sand,	Banks of Arkansas River.

Hydrophyllaceæ.

Hydrophyllum, L.,	Water-leaf.		
*H. Virginicum, L.,		Alluvial,	Rich woods.
Nemophila, Nutt.			
*N. microcalyx, F. & M.,			Rich moist woods.
*N. phaceloides, Nutt.,			Cedar prairie near Fort Smith.
Ellisia, L.			
*E. ranunculacea, Nutt.			
Phacelia, Juss.			
P. hirsuta, Nutt.,			Cadron River.
*P. glabra, Nutt.,			"
P. Purshii, Buck.,			Banks? (M. Cox.)
Hydrolea, L.			
*H. ovata, Nutt.			

[1] Plants of this family contain a sweet and emollient mucilage, more abundant in the roots, employed as sedative. Some species have in the root a red coloring matter used in dyeing.

[2] Its root is used for dyeing red. Common in Arkansas.

Latin Names.	English Names.	Geolog'l Station.	Natural Habitat.
		Polemoniaceæ.	
Polemonium, Tour.,	Greek Valerian.		
P. reptans, L.,		Limestone,	Shady river banks, &c.
Phlox, L.			
P. paniculata, L.,			Rich woods.
*P. maculata, L.,			" and banks.
P. pilosa, L.,		Sandstone,	Prairies and rocky hills.
*P. reptans, Mich.,			Damp woods.
*P. glomerata, Nutt.			
Gilia, Ruiz.			
*G. coronopifolia, Pers.,		Sand,	Dry prairies.
		Convolvulaceæ.[1]	
Ipomœa, L.,	Morning-glory.		
*I. purpurea, Lam.,			Nuttall's Catalogue.
*I. Nil, L.,			" "
*I. lacunosa, L.,			Woods and fields.
*I. pandurata, Mey.,		Sandy,	Fields and dry banks.
*I. tamnifolia, Willd.,		"	Banks of Mississippi Riv.
Convolvulus, L.,	Bindweed.		
*C. arvensis, L.,	"	Sandy,	Fields.
*C. hastatus, Nutt.,			Red River.
Evolvulus, Mich.			
*E. nummularius, Mich.,			Mississippi, banks.
*E. pilosus, Nutt.,			Red River.
Dichondra, Forst.			
*D. repens, F.,			Moist ground.
Cuscuta, Tourn.,	Dodder.		
*C. Gronovii, Willd.,		On Herbes,	Shady marshy places.
C. glomerata, Chois.,		On Compositæ,	Wet prairies.
		Solanaceæ.[2] *Nightshade Family.*	
Solanum, L.,	Nightshade.		
S. nigrum, L,			Waste places.
S. Caroliniense, L.,	Horse-Nettle,	Sand,	Road and dry barren.
Physalis, L.,	Ground Cherry.		
P. Philadelphica, Lam.,		Sandy,	Barren soil.

[1] The roots of all the Bind-weeds (Convolvulus) have a milky, bitter, and purgative sap. When the principle is in small quantity and mixed with fecula, it becomes rather aromatic, and the root becomes a wholesome food for man, as in the Sweet Potato (Convolvulus-batatas).

[2] The plants of this family, at least their stems and leaves, are sometimes poisonous. The roots and the fruits of some species are wholesome food, like the Potato and the Tomato. American species appear far less poisonous than European ones. Thus the fruits of our Physalis (Ground cherries), are eaten by children, and Tobacco is chewed by everybody without inconvenience. The Egg plant (*Solanum esculentum*), the Red pepper (*Capsicum annuum*), the Tomato (*Lycoperdon esculentum*), and others belong to this family.

LATIN NAMES.	ENGLISH NAMES.	GEOLOG'L STATION.	NATURAL HABITAT.
*P. pubescens, L.,			Low ground.
P. viscosa, L.,			Waste places.
*P. pumila, Nutt.,			Arkansas. Nutt. Cat.
*P. longifolia, Nutt.,			Sandy banks of Arkan. R.
*P. mollis, Nutt.,			" " "
Datura, L.,	Thorn apple.		
D. stramonium, L.,[1]	"	Alluvial,	Waste grounds.

Gentianaceæ.[2] *Gentian Family.*

Sabbattia, Adans.,	Centaury.		
S. angularis, Pursh.,[3]			Prairies and low thickets.
*S. campestris, Nutt.,			Prairies of Red River.
Gentiana, L.,[4]	Gentian.		
G. ochroleuca, Frœl.,[5]			Prairies around Fayettv'e.
G. Andrewsii, Gris.,			Rich wet prairies.
G. saponaria, L.,			Woods and prairies.
G. puberula, Mich.,		Cherty Limestone,	Dry rocky prairies.
Limnanthemum, Gmel.,	Floating Heart.		
L. lacunosum, Gris.,			Ponds and bayous. Floating.

Asclepiadaceæ.[6] *Milkweed Family.*

Asclepias, Tour.,	Milkweed.		
? A. cornuti, D C.,			Rich soil.
A. variegata, L.,			Prairies.? (M. Cox.)
*A. Nuttalliana, Tor.,			Prairies.
*A. parviflora, Pursh.,		Sand,	Barren.
A. paupercula, Mich.,		Cherty Limestone,	Dry barren.
A. tuberosa, L.,[7]	Pleurisy root,		Prairies and fields.
*A. verticillata, L.,		Sandy,	Dry hills.
Apocynum, Tour.,	Dogbane.		
A. cannabinum, L.,			Thickets and roads, &c.
Acerates, Ell.,	Green Milkweed.		
*A. viridiflora, Ell.,		Sand,	Fields and dry hills.

[1] A poisonous plant introduced from Asia. Children have died from eating the seeds. The Tobacco, *Nicotiana rustica* and *N. tabacum*, are found around the plantation in woods and rich land.

[2] All the plants of this family have in their stems, leaves, and roots a very bitter principle, which makes them useful as tonic, stomachic, and febrifuge remedies.

[3] Roots used as tonic and stomachic remedy. The four-angled stem, about one foot high, has opposite oval and acute leaves, and deep rose-purple showy flowers, wheel-shaped, with five or six divisions. Common.

[4] Fine blue or white funnel-form flowers, the last of the prairie flowers in the fall with the compositæ. Root very bitter.

[5] Not common in Arkansas. A specimen was brought to me at Fayetteville as a great remedy against the Piles! It is bitter and tonic, nothing else.

[6] Some exotic species are used in medicine, but none of our American species.

[7] A fine species, with long grapes of orange flowers. Common on the prairies. Its name, Pleurisy root, comes from the sudorific property of its root, which is used in Pleurisy to excite the perspiration.

LATIN NAMES.	ENGLISH NAMES.	GEOLOG'L STATION.	NATURAL HABITAT.
*A. paniculata, Dec.,		Sand,	Barren. Nutt. Cat.
*A. longifolia, Ell.,		"	Moist. Fort Smith.
Enslenia, Nutt.			
E. albida, Nutt.,			River banks.
Gonolobus, Mich.			
G. macrophyllus,			River banks? (M. Cox.)

Oleaceæ.[1] *Olive Family.*

Olea, Tour.,	Olive.		
*O. Americana, L.,[2]	Devil-wood.	Sand,	Nutt. Cat.
Chionanthus, L.,	Fringe-tree.		
? C. Virginica, L.,		Sandstone?	River banks.
Fraxinus, L.,	Ash.		
F. Americana, L.,[3]	White ash,		Rich woods.
F. viridis, Mich.,	Green ash,	Limestone,	Banks of streams.
F. sambucifolia, Lam.,	Black ash,[4]	"	Swamps and banks.
*F. quadrangulata, Mich.,	Blue ash,	"	Moist rich woods.
*F. platycarpa, Mich.,	Caroline water ash,		Wet woods.
Forestiera, Poir.			
F. acuminata, Poir.,		Limestone,	Banks of White River.
*F. pubescens, Nutt.,			Plains of Red River.

Aristolochiaceæ.[5] *Birthwort Family.*

Asarum, Tour.,	Asarabacca.		
A. Canadense, L.,[6]		Sandstone,	Rich woods and hillsides.
Aristolochia, Tour.,	Birthwort.		
A. serpentaria, L.,[7]	Virginia Snakeroot,	Limestone,	Woods and rocks.
*A. tomentosa, Sims.,			Rich woods.

Nyctaginaceæ. *Four O'Clock Family.*

Oxibaphus, Vahl.			
*O. nyctagineus, Sweet.,		Limestone,	Rocky places.
*O. angustifolius, Sw.,			Nutt. Cat.
O. albidus, Sweet.,		Magnesian Limest.,	Barrens.

[1] Trees with bitter and astringent bark.

[2] Wood compact, fine-grained, extremely hard, and difficult to split. Hence its name. It grows ordinarily near the coasts, but is mentioned in Nuttall's catalogue as found in Arkansas.

[3] Wood tough, hard, and elastic. Especially used by wagonmakers and for agricultural implements. Extensively exported to Europe for the use of the navy. The exudation of the bark of the White Ash is used as a lenient purgative. All the species have the same property, and the wood is also of the same kind.

[4] Wood very tough, easily separated in thin layers for making baskets, &c.

[5] Roots bitter, tonic, stimulating, of no well-defined properties.

[6] An Indian medicine. Its bitter root is known as Wild Ginger. It has probably some stimulating property.

[7] Easily known by its peculiar flower, placed near the root, and with the tube of the corolla curved like a pipe. Root aromatic and stimulant. Has been used against the bite of snakes.

LATIN NAMES.	ENGLISH NAMES.	GEOLOG'L STATION.	NATURAL HABITAT.
Phytolacaceæ. *Pokeweed Family.*			
Phytolacca, Tour.,	Pokeweed.		
P. decandra, L.,[1]	Poke. Garget. Pigeon Berry,		Rich soil.
Rivinia, Plum.			
*R. portulacoides, Nutt.,		Alluvial,	Verdigris River.
Chenopodiaceæ.[2] *Goosefoot Family.*			
Chenopodium, L.,	Pigweed.		
*C. hybridum, L.,	Maple-leaved goosefoot,		Waste places. (Introd.)
C. album, L.,	Lambs' quarters,		" "
C. ambrosioides, L., & var.	Wormseed,		" "
Atriplex, Tour.,	Orache.		
*A. hortensis, L.,			Cultivated. (Nutt. Cat.)
Chenopodina, Moq.,	Sea goosefoot.		
*C. maritima, Moq.,			Salt marshes. "
Amaranthaceæ.[3] *Amaranth Family.*			
Amaranthus, Tour.,	Amaranth.		
*A. hybridus, L.,			Waste places. (Introd.)
*A. albus, L.,			" "
Montelia, Moq.			
*M. tamariscina, Nutt.,		Sand,	Banks of Arkansas River.
Iresine, R. Br.			
I. celosioides, L.,		Alluvial,	Shady rich soil.
Froelichia, Moench.			
*F. Floridana, Moq.,			Nutt. Cat.
Achyranthes, Ell.			
*A. repens, Ell.,			Waste places.
*A. lanuginosa, Nutt.,			Salt River.
Polygonaceæ.[4] *Buckwheat Family.*			
Polygonum, L.,	Knotweed.		
P. amphibium, L.,	Water Persicaria,	Limestone,	Springs. Mammoth Spg.
P. hydropiperoides, Mich.,	Water-Pepper,	"	Creeks and swamps.

[1] Species known everywhere. A poisonous plant, especially the roots. Leaves and berries dangerous and violent purgative. The berries infused in brandy are used in cases of chronic Rheumatism resulting from syphilitic diseases. (Barton.) The thickened sap of the berries is also used against scrofulas, and even is said to have cured Cancer. The young shoots of the plant in spring lose their acridity by boiling, and are said to be better than asparagus.

[2] Mostly introduced weeds. The leaves and roots of some of them—the Spinac (*Spinacia oleracea*), the Beet (*Beta vulgaris*)—give a wholesome food. Those growing near the sea contain Soda, which is obtained from their ashes.

[3] Mostly introduced weeds.

[4] In this family, we find plants with bitter, aromatic, and purgative roots, like the Rhubarb; or with pleasant acid and wholesome stems and leaves, like the stems of the Rhubarb and the leaves of the Sorrel. Some have mealy seeds, as the Buckwheat (*Fagopyrum esculentum*). One of our very common species, the Knot-grass or door-weed (*Polygonum aviculare*), has the seeds emetic and purgative. I have not seen the Buckwheat in Arkansas.

LATIN NAMES.	ENGLISH NAMES.	GEOLOG'L STATION.	NATURAL HABITAT.
*P. hirsutum, Walt.,		Sand,	Barren. (Nutt. Cat.)
P. aviculare, L.,	Knot-grass,	"	Waste places.
*var. erectum, Roth.,			Prairies.
*P. tenue, Mich.,		Sand,	Dry soil. Rocky hills.
*P. articulatum, L.,	Joint-weed,	"	" (Nutt. Cat.)
*P. Virginianum, L.,			Rich soil. Thickets, &c.
P. Sagittatum, L.,	Tear-Thumb,		Low rich ground.
*P. convolvulus, L.,			Cultivated. (Nutt. Cat.)
P. dumetorum, L.,	Climbing Buckwheat,		Moist thickets, &c.
Rumex, L.,	Dock-Sorrel.		
*R. verticillatus, L.,	Swamp-Dock,		Swamps and ditches.
R. crispus, L.,	Curled-Dock,		Waste places. (Introd.)
*R. maritimus, L.,	Golden-Dock,	Sand,	Saline soil. (Nutt. Cat.)
R. acetosella, L.,	Sheep-Sorrel,		Old fields.
Brunnichia, Banks.			
*B. cirrhosa, B.,		Sand,	Banks of rivers.
Eriogonum, Mich.			
E. longifolium, Nutt.,		Limestone,	Barrens.
*E. annuum. Nutt.,			Salt River.

Lauraceæ.[1] *Laurel Family.*

Sassafras, Nees.,	Sassafras.		
S. officinale, Nees.,[2]	"	Limestone,	Rich woods, borders of [prairies.
Benzoin, Nees.,[3]	Wild allspice.		
B. odoriferum, Nees.,	"	Lime, alluvial, & rocks,	Rich soil, marshy woods.

Thymeleaceæ.

Dirca, L.,	Leatherwood.		
D. palustris, L.,[4]			Damp, rich woods.

Santalaceæ. *Sandal-wood Family.*

Comandra, Nutt.,	Bastard Toad-flax.		
*C. umbellata, Nutt.,	"		Dry ground.
Pyrularia, Mich.			
*P. oleifera, Gray,			Rich wood banks.

Loranthaceæ. *Mistletoe Family.*

Phoradendron, Nutt.,	Mistletoe.		
P. flavescens, Nutt.,			Parasite on trees.

[1] Trees or shrubs with aromatic wood, bark, and leaves. This property is especially marked in the Cinnamomum. Camphor is the Gum of a Laurel. The greatest number of species are tropical.

[2] This shrub is known by everybody. The bark and leaves have an aromatic taste, and are used in infusion as a stimulating drink. Michaux says that its wood is never attacked by insects, and recommends it for making bedsteads.

[3] It was employed as Spice during the American War, being, like the former, strongly aromatic, but less common.

[4] The bark of this species is acrid, fibrous, and very tough. It was used by the Indians for thongs, hence the popular name. (Gray.)

Latin Names.	English Names.	Geolog'l Station.	Natural Habitat.
		Saururaceæ.	
Saururus, L.,	Lizard's tail.		
S. cernuus, L.,		Limestone,	Ponds and bayous.
		Ceratophyllaceæ.	
Ceratophyllum,	Hornwort.		
C. demersum, L.,			Ponds and bayous.
		Callitrichaceæ.	
Callitriche, L.,	Water Starwort.		
C. verna, L.,		Limestone,	Springs.
*C. pedunculata, D C.,			Nutt. Cat.
C. autumnalis, L.,		Limestone,	Mammoth Spring.
*C. peploides, Nutt.,			Banks of Mississippi.
	Euphorbiaceæ.[1]	*Spurge Family.*	
Euphorbia, L.,	Spurge.		
? E. polygonifolia, L.,		Sand,	Banks.
*E. herniarioides, Nutt.,		"	Banks of Mississippi R.
E. maculata, L.,		"	Dry open places.
E. hypericifolia, L.,		"	Dry prairies.
*E. cyathophora, Jacq.,			Nutt. Cat.
E. corollata, L.,		Limestone,	Dry rocky prairies.
*E. obtusata, Pursh.,			Shady fertile woods.
*E. graminifolia, Mich.,			Nutt. Cat.
*E. arenaria, Nutt.,		Sand,	Arkansas River.
*E. heterantha, Nutt.,		"	" "
*E. peploides, Nutt.,			Fort Smith.
*E. marginata, Nutt.?		Sand,	Arkansas River.
Cnidoscolus, Pohl.,	Spurge-Nettle.		
*C. stimulosa, Gray,		Sand,	Banks. (Nutt. Cat.)
Acalypha, L.,	Three-seeded Mercury.		
A. Virginica, L.,		Limestone,	Fields and prairies.
A. gracilens, Gray,		Limestone,	Barrens and rocky places.
Tragia, Plum.			
T. urticæfolia, Mich.,		Limestone,	Rocky barren.
*T. angustifolia,[2] Nutt.,			Red River. Plains.
*T. betonicæfolia, Nutt.,[2]			" "
Stillingia, Gard.			
S. lanceolata, Nutt.,			Fort Smith, &c.
Croton, L.			
C. capitatum, Mich.,		Limestone,	Barrens.
*C. glandulosum, L,			Open waste places.
C. monanthogynum, Mich.,		"	Barrens.
*C. muricatum, Nutt.,			Nutt. Cat.

[1] All the plants of this family have a milky, acrid, and caustic sap, which is sometimes poisonous, taken internally. By external application, it is used as a caustic for destroying the warts of the skin. Some exotic species are used in medicine.

[2] Perhaps both these species are only varieties of *Tragia urens*, L.

Latin Names.	English Names.	Geolog'l Station.	Natural Habitat.
Aphora, Nutt.			
*A. mercurialina, Nutt.,			Red River plains.
Phyllanthus, L.			
P. Caroliniensis, Walt.,		Limestone,	Banks.

Urticaceæ.[1] *Nettle Family.*

Ulmus, L.,	Elm.		
U. fulva, Mich.,[2]			Rich woods.
U. Americana, L.,[3]		Limestone,	Moist rich soil and gravel.
U. alata, Mich.,[4]		"	Everywhere.
U. crassifolia, Nutt.,		"	Rocks and prairies.
Celtis, Tour.,	Nettle-tree. Hackberry.		
C. occidentalis, L.,[5]	Sugarberry,	Alluvial,	Rich moist soil.
C. Mississipiensis, Bosc.,		Sand,	Banks and barren.
Morus, Tour.,	Mulberry.		
M. rubra, L.,[6]		Limestone,	Banks and rich woods.
Urtica, Tour.,	Nettle.		
*U. gracilis, Ait.,			Moist ground. (Nutt. Cat.)
*U. urens, L.,			Waste ground. "
*U. purpurascens, Nutt.,		Alluvial,	Shady, rocky places.
Laportea, Gaud.,	Wood-Nettle.		
L. Canadensis, Gaud.,		Limestone,	Moist rich woods.
Boehmeria, Jacq.,	False Nettle.		
*B. cylindrica, Willd.,			Woods. (Nutt. Cat.)
Parietaria, Tour.,	Pellitory.		
*P. Pennsylvanica, Muhl.,			Shaded banks.
Cannabis, Tour.,	Hemp.		
C. sativa, L.,[7]		Limestone,	Gravelly banks, waste places, &c.
Humulus, L.,	Hop.		
H. Lupulus, L.,[8]		Limestone,	Banks of streams.

Platanaceæ.

Platanus, L.,	Plane-tree. Buttonwood.		
P. occidentalis, L.,[9]	Sycamore. "	Alluvial,	Rich banks.

[1] Plants very different in size, forms, and properties. Some are poisonous to the highest degree. Some, like the Fig-tree, bear wholesome fruits; some, like the Pepper, have aromatic berries; some a fine wood, like our Elms; and some a tough flexible bark, like the Hemp, the Nettle, &c.

[2] A small tree, with mucilaginous inner bark, eaten by children and used as emollient in infusion. The heart wood is of a dull red color, less compact than that of the following species.

[3] Wood dark brown, very strong, but easily decaying. It attains a great size.

[4] Most common in Arkansas, but mostly a shrub. Grows everywhere, and on every kind of soil.

[5] According to Michaux, the wood is but little esteemed. When perfectly seasoned, it is hard, compact, and tenacious.

[6] A small tree. Wood durable, strong, valuable for making posts. Its leaves have been used, like those of the White mulberry, for the food of the silk-worms.

[7] The Hemp is scarcely cultivated in Arkansas, being replaced by cotton. It needs for its culture a good, deep, fertile soil, or a bottom land not too retentive of water. The use of its bark is well known. From its leaves and flowers is made the Hachichin, a preparation which acts on the body like opium, causing a kind of delirious drunkenness which enervates and kills like a slow poison.

[8] Cultivated in gardens and escaped. Its use is well known.

[9] Tree very large. Wood of but little value.

Latin Names.	English Names.	Geolog'l Station.	Natural Habitat.
	Juglandaceæ.		
Juglans, L.,	Walnut.		[(rare).
J. cinerea, L.,[1]	Butternut,	Alluvial,	Rich woods and bottoms
J. nigra, L.,[2]	Black Walnut,		" " (common).
Carya, Nutt.,	Hickory.		
C. olivæformis, Nutt.,[3]	Pecan nut,	Alluvial,	Deep bottoms near Miss. R.
C. alba, Nutt.,[4]	Shell-bark Hickory	Sandstone,	Rich woods.
*C. sulcata, Nutt.,	Thick Shell-bark Hickory,	"	" (rare).
C. tomentosa, Nutt.,	Mockernut,	Limestone, &c.,	Dry rocky woods, &c.
C. glabra, Tor.,	Pig-nut,	Sandstone,	Hickory barrens.
*C. amara, Nutt.,[5]	Bitternut,	Alluvial,	Swamps and woods.
*C. aquatica, Nutt.,			
	Cupuliferæ.	*Oak Family.*	
Quercus, Mich.,	Oak.		
Q. macrocarpa, Mich.,[6]	Over-cup or Bur-oak,	Alluvial Lime.,	Rich banks (rare).
Q. obtusiloba, Mich.,[7]	Post-oak,	Sand and lime, &c.,	Dry barren, sterile soil.
Q. alba, L.,[8]	White oak,	" "	On every soil.
Q. Prinus, L.,[9]	Swamp Chestnut-oak,	Alluvial,	Low ground.
Q. montana, Willd.,[10]	Rock Chestnut-oak,	Sandst. & Limest.,	Rocky creeks.
Q. bicolor, Willd.,[11]	Swamp White-oak,	Alluvial,	Bottoms of Washita River.
Q. Castanea, Willd.,[12]	Yellow Chestnut-oak,	Limestone,	Banks of rivers (rare).
*Q. prinoides, Willd.,[13]	Chinquapin Oak,	Sandy,	Barrens.
Q. lyrata, Walt.,[14]	Over-cup Oak,	Alluvial,	Bottoms in marshy places.

[1] Wood light, of little strength, but durable and resisting the effects of heat, moisture, &c. Used for window sashes. Michaux says that its bark is purgative. The fruits, gathered before maturity, are preserved in sugar, or infused in brandy as an excellent stomachic and tonic.

[2] Wood becoming black by seasoning, strong, very tenacious, fine-grained, susceptible of a fine polish. Much used for cabinet-work, and as fine as mahogany.

[3] The nut is known everywhere. Wood coarse-grained, heavy, compact, durable, but not as valuable as other species of Hickory.

[4] The wood of this species, says Michaux, possesses all the characteristic properties of the Hickory, being strong, elastic, and tenacious. It has also the common defects of soon decaying and being eaten by worms.

[5] The timber of this species is inferior to the other species. It is generally a small tree.

[6] Stiff, durable wood, as good for fuel as the white oak. It is rare in Arkansas; at least I saw very few specimens of it on our way.

[7] A small tree. Hard, durable wood, valuable for posts. Most common in Arkansas.

[8] One of our most valuable species of trees, becoming very large on a good alluvial or rich limestone soil. Wood hard, durable, much used for different purposes. Its bark is tonic, astringent, and used in medicine. Variable in size, following the ground which it inhabits.

[9] A fine large tree. Its wood is inferior to the White Oak. (Gray.)

[10] It follows the rocky creeks and torrents where no other tree can grow. A small tree, considered a variety of the former; but I could not find it passing to it either in station or in form

[11] Not common. A fine large tree, branching high above the ground. Named in Arkansas, Swamp-Burr Oak.

[12] Acorns small, scarcely larger than a pea. I saw it only on limestone banks near White River. It is common enough east of the Mississippi.

[13] Only a shrub. I did not see it in Arkansas.

[14] A fine large tree, one of the largest and most highly estimated among the Oaks (says Michaux). It grows in deep, marshy bottoms, near shallow creeks, in the same habitat as the Cypress and the great Tupelo. Scarce in Arkansas, at least in the upper region. Seen only near Washita River.

Latin Names.	English Names.	Geolog'l Station.	Natural Habitat.
Q. Phellos, L.,[1] .	Willow oak, . .	Alluvial, . .	Bottoms in marshy places.
Q. imbricaria, Mich.,[2]	Laurel or shingle-oak,	Limestone, .	Banks and high bottoms.
Q. aquatica, Cat.,[3] .	Water oak, . .	Alluvial, sandy,	Bottoms and flats.
Q. nigra, L.,[4] . .	Black-Jack oak, .	Sand and lime, .	Barren.
Q. falcata, Mich.,[5] .	Spanish oak, . .	Sandstone, .	Dry sandy plains & ridges.
Q. tinctoria, Bart.,[6]	Black oak, Quercitron,	Sand and lime, .	Plains and ridges.
Q. coccinea, Wang.,[7]	Scarlet oak, . .		Hills and rich woods.
Q. rubra, L.,[8] . .	Red oak, . .		Rocky woods, creeks, &c.
Q. palustris, D. R.,[9]	Pin oak, . .	Alluvial, . . .	Low ground, borders of swamps & prairies.
Castanea, Tour., .	Chestnut.		
C. vesca, L.,[10] .	" . . .	Sandstone & chert,	Rocky hills (rare).
C. pumila, Mich.,[11] .	Chinquapin, . .		" (common).
*C. nana, Muhl., .	Dwarf Chinquapin,		Hills of Arkansas River.
Fagus, Tour., .	Beech.		
F. sylvestris, Mich.,[12]	White Beech, . .	Alluvial & tertiary,	Washita River and Southward.
Corylus, Tour., .	Hazel-nut.		
C. Americana, Walt.,	" . .	Sandy, . .	Thickets around prairies.
Carpinus, L., .	Hornbeam.		
C. Americana, Mich.,[13]	" . . .	Limestone,	Banks and creeks.
Ostrya, Mich., .	Iron wood.		
O. Virginica, Willd.,			

[1] Abounds from Hurricane Creek southward, in all the swampy bottoms and flats, where it bears abundance of acorns. Wood reddish, coarse-grained, porous, not much used.

[2] Pretty rare in Arkansas. Wood hard, heavy, fit for fuel only. Has been used for shingles. (Michaux.)

[3] It ranges from Sebastian County, or rather from Fort Smith to Memphis, or from this parallel southward. I did not see it north of this line. The tree becomes of good size, more than fifty to sixty feet high. Its leaves are extremely variable, showing all possible forms between the Willow and the Post-oak leaves, even sometimes cut and spiny. Wood very tough (says Michaux), but less durable and less estimated by carpenters and wheelwrights than that of the White Oak.

[4] A small crooked tree. Wood compact, coarse-grained, good for fuel.

[5] Becomes a large tree in deep sandstone soil. In barren sandstone it is mostly stunted, and pass to *Quercus tridentata*, Engl. Wood less durable, and less estimated than that of the White Oak. Bark preferable for tanning

[6] A large tree, with reddish, strong, durable wood. The Quercitron is a yellow coloring matter, obtained from the cellular or inner bark of this tree.

[7] Grows with the former species. Wood not as good. Used for staves. Poor for fuel. It is easily distinguished from the next by its scaly acorns.

[8] It likes limestone and lime soil; very common in Arkansas, and found at various stations. Easily distinguished by its large acorns and flat shallow cup. Wood reddish, strong, porous, not very valuable. Bark used for tanning.

[9] The foliage is most like that of the former; but its acorn is globular, and scarcely half as long. Wood strong, tenacious, not durable. Used for staves.

[10] I did not see in Arkansas a tree of good size of this species, but only shrubby. Wood strong, elastic, durable, good for posts, &c.

[11] The Chinquapin is more common in Arkansas than the Chestnut. Its wood is still stronger and more compact.

[12] Becomes of enormous size in the bottoms in rich deep soil, not too wet. Wood too hard and too heavy for timber, but very good for fuel.

[13] A slender tree like the next, with white, compact, hard wood. Both this and next species have also the same kind of wood, and are generally known under the name of Iron-wood. Its fruit is inclosed in a ring of loose catkin, while that of the next species has the seed enveloped and bordered with a leaflike, cut calyx.

Latin Names.	English Names.	Geolog'l Station.	Natural Habitat.
	Myricaceæ. *Sweet Gale Family.*		
Myrica, L.,	Bayberry.		
M. cerifera, L.,[1]	"	Sandy,	Alluvial swampy ground.
	Betulaceæ. *Birch Family.*		
Betula, Tour.,[2]	Birch.		
*B. populifolia, Ait.,	White Birch,	Sandstone,	Barren. (Nutt. Catt.)
B. nigra, L.,	Red Birch,	"	River banks.
Alnus, Tour.,	Alder.		
A. serrulata, Ait.,	Smooth Alder,	Limestone,	Gravel & banks of creeks.
	Salicaceæ.		
Salix, Tour.,	Willow.		
S. discolor, Muhl.,	Glaucous Willow,		River banks.
S. nigra, Marsh.,	Black Willow,		" "
*S. longifolia, Muhl.,			Nutt. Cat.
Populus, Tour.,	Poplar.		
P. monilifera, Ait.,[3]	Cotton-wood,	Alluvial sandy,	Bottoms along rivers.
*P. angulata, Ait.,		"	Low grounds.
	Coniferæ. *Pine Family.*		
Pinus, Tour.,	Pine.		
*P. inops, Ait.,	Jersey Pine,	Sandstone,	Barren. (Nutt. Cat.)
P. mitis, Mich.,[4]	Yellow Pine of the North,	Sandstone & chert,	Barren hills (common).
*P. rigida, Mill.,[5]	Pitch Pine,	Sand,	Nutt. Cat.
P. Tæda, L.,[6]	Loblolly Pine,	Tertiary,	Alluvial and sandy hills.
Taxodium, Rich.,	Bald Cypress.		
T. distichum, Rich.,[7]	"	Alluvial,	Deep swamps.
Juniperus, L.,	Juniper.		
J. Virginiana, L.,[8]	Red Cedar,	Limestone,	Banks of rivers, rocks. Mouth of Benetz Bayou.
	Araceæ. *Arum Family.*		
Arisæma, Mart.,	Indian turnip.		
*A. triphyllum, Tor.,			Rich soil and woods.
*A. Dracontium, Schott,			Low ground.
Acorus, L.,	Sweet flag. Calamus.		
A. Calamus, L.,[9]	"		Swampy prairies.

[1] The berries are invested with a kind of wax, which, collected by boiling, is used for candle-making.

[2] The wood of the Birches is not very valuable. It is soft and light.

[3] Wood white, soft, unfit for use. I have not seen this tree in Arkansas, except with the Arkansas River bottoms and the creeks running to it across the Millstone grit, Frog bayou, &c. None in the north of the State.

[4] Wood fine-grained, a little resinous, yellowish white, used for flooring, &c.

[5] I have not seen it in Arkansas. It is the most valuable Yellow Pine of the South.

[6] Grows south of Hot Springs County, mixed with the Yellow Pine, and is used for the same purpose, though not as good.

[7] Wood fine-grained, reddish, strong, elastic, and less resinous than that of the Pines. Much used for building in the South, and very valuable.

[8] Wood reddish, odorous, strong, tough, and durable. The species is rare in Arkansas.

[9] Root creeping, sweet-scented, aromatic, and somewhat tonic. It is highly praised as a valuable popular medicine, but its properties are scarcely ascertained.

Latin Names.	English Names.	Geolog'l Station.	Natural Habitat.
	Typhaceæ. *Cat-tail Family.*		
Typha, Tour.,	Cat-tail flag.		
T. latifolia, L.,	"		Ponds and bayous.
Sparganium, Tour.,	Bur-reed.		
S. simplex, Huds.,		Limestone springs,	Mammoth Spring.
	Lemnaceæ. *Duckweed Family.*		
Lemna, L.,	Duck meat.		
L. trisulca, L.,	"	Floating,	Mammoth Spring.
L. minor, L.,	"	"	" "
*L. polyrrhiza, L.,[1]	"	"	Nutt. Cat.
	Palmæ. *Palms.*		
Sabal, Adans.,[2]	Palmetto.		
S. Adansoni, Guer.,	"	Alluvial,	Deep marshes mouth of Arkansas River.
	Naiadaceæ. *Pondweed Family.*		
Zannichellia, Mich.,	Horned Pondweed.		
Z. palustris, L.,	"		Mammoth Spring.
Potamogeton, Tour.,	Pondweed.		
P. compressus, L.,			" "
P. prælongus, Wullf.,			" "
P. natans, L.,			" "
*P. heterophyllus, Schr,			Nutt. Cat.
	Alismaceæ. *Water Plantain Family.*		
Alisma, L,	Water plantain.		
A. Plantago, L.,	" "		Ditches. Ponds.
Echinodorus.			
*E. rostratus, Engl.,			Ponds of Verdigris River.
Sagittaria, L.,	Arrow-head.		
*S. radicans, Nutt.,			Shallow water. Ft. Smith.
*S. variabilis, Engel.,			" and wet places.
*S. simplex, Pursh.,			" "
	Hydrocharidaceæ. *Frog's-bit Family.*		
Limnobium, Rich.,	Frog's bit.		
L. Spongia, Rich.,			Ponds.
Anacharis, Rich.,	Water weed.		
A. Canadensis, Pl.,	"		Mammoth Spring.
Valisneria, Mich.,	Eel-grass.		
*V. spiralis, L.,			Slow rivers. (Nutt. Cat.)

[1] *Lemna perpusilla*, Torr., is also probably a species of Mammoth Spring. I could not find it in fruit.

[2] M. Nuttall says that this Palm first makes its appearance a few miles below the Southern boundaries of the Arkansas Territory, on the banks of the Mississippi River. It is now found in abundance at the mouth of Arkansas River, back of the town of Napoleon. Has this species changed its distribution ascending northward, or has it escaped the attention of M. Nuttall, one of the most careful, exact, and attentive explorers?

LATIN NAMES.	ENGLISH NAMES.	GEOLOG'L STATION.	NATURAL HABITAT.
	Orchidaceæ. *Orchis Family.*		
Spiranthes, Rich.,	Ladies' Tresses.		
S. annua, Rich.,		Chert,	Wet prairies.
Pogonia, Juss.			
*P. pendula, Lindl.,			Rich damp woods.
Calopogon, R. Br.			
*C. pulchellus, R. Br.,			Bogs.
Tipularia, Nutt.,	Cane-fly Orchis.		
*T. discolor, Nutt,		Sandy,	Pine woods. (Nutt. Cat.)
Microstylis, Nutt.,	Adder's mouth.		
*M. ophioglossoides, Nutt.,			Damp woods.
Cypripedium, L.,	Lady's slipper.		
*C. pubescens, Willd.,		Sandy,	Woods and hills.
	Amaryllidaceæ.		
Pancratium, L.			
*P. maritimum, L.,		Sand,	Salt marshes. (Nutt. Cat.)
Crinum, L.			
*C. Americanum, L.,		Alluvial,	Swamps. "
Agave, L.,	American Aloe.		
A. Virginica, L.,		Limestone,	Rocks.
Hypoxis, L.,	Star-grass.		
*H. erecta, L.,		Sandy,	Open woods.
	Hæmodoraceæ. *Bloodwort Family.*		
Aletris, L.,	Colic root.		
*A. farinosa, L.,		Sandy,	Shady places.
*A. aurea, Walt.,		Sand,	Barren.
	Bromeliaceæ. *Pine-Apple Family.*		
Tillandsia, L.,	Long Moss.		
*T. usneoides, L.,			On trees, especially the Live Oak.[1]
	Iridaceæ. *Iris Family.*		
Iris, L.,	Flower de Luce. Blue flag.		
*I. versicolor, L.,			Wet places.
*I. Virginica, L.,			Marshes.
I. cristata, Ait,		Sandstone,	Hills and dry ridges.
Nemastylis, Nutt.			
*N. cœlestina, Nutt.,		Sandstone,	Rocky pine woods.
N. geminiflora, Nutt.,		"	" "

[1] On this species, Nuttall says that its first appearance along the Mississippi is in the Cypress land near the Southern confines of Arkansas. Scarcely, if ever, found in the State limits.

Latin Names.	English Names.	Geolog'l Station.	Natural Habitat.
	Dioscoreaceæ. *Yam Family.*		
Dioscorea, Plun.,	Yam.		
*D. quaternata, Walt.,			Arkansas. (Nutt. Cat.)
	Smilaceæ.		
Smilax, Tour.,	Greenbrier.		
S. rotundifolia, L.,			Thickets (common).
*S. glauca, Walt.,			Dry thickets.
*S. tamnoides, L.,			Thickets.
S. lanceolata, L.,		Alluvial,	Swamps. Washita River.
S. laurifolia, L.,		Sandy,	Pine barren.
S. herbacea, L.,		Alluvial,	Banks of rivers.
Trillium, L.,	Three-leaved Nightshade.		
*T. sessile, L.,			Woods.
*T. unguiculatum, Nutt.,			Shady woods.
*T. viridescens, Nutt.,			" "
	Liliaceæ. *Lily Family.*		
Polygonatum, Tour.,	Solomon's seal.		
*P. biflorum, Ell.,			Wooded banks.
*P. multiflorum, Ell.,			Arkansas. (Nutt. Cat.)
Smilacina, Desf.,	False Solomon's seal.		
*S. racemosa, Desf.,			Moist copses.
*S. stellata, Desf.,			" "
Scilla, L.,	Squill.		
S. Fraseri, Gray,[1]	Quamash,		Thickets & moist prairies.
Allium, L.,	Garlic.		
A. stellatum, Nutt.,			Prairies (rare).
*A. angulosum, B. Nutt.,			Arkansas. (Nutt. Cat.)
*A. ochroleucum, Nutt.,			Prairies. "
*A. Canadense, Kalm.,			Moist prairies.
A. striatum, Jacq.,			Prairies. (M. Cox.)
Lilium, L.,	Lily.		
*L. Philadelphicum, L.,			Prairies and copses.
*L. superbum, L.,		Alluvial,	Rich low ground.
Erythronium, L.,	Dog's-tooth Violet.		
*E. Americanum, Sm.,		Limestone,	Banks and thickets.
*E. albidum, Nutt.,		"	" "
Yucca, L.,	Spanish bayonet.		
*Y. recurvifolia, Salisb.,			Arkansas. (Nutt. Catt.)
	Melanthaceæ.		
Uvularia, L.,	Bellwort.		
*U. sessilifolia, L.,			Nutt. Cat.
Melanthium, Gron.			
*M. Virginicum, L,			Wet meadows.

[1] Bulb sweet to the taste, and eatable.

LATIN NAMES.	ENGLISH NAMES.	GEOLOG'L STATION.	NATURAL HABITAT.
Stenanthium, Gray.			
*S. angustifolium, Gray,			Wet meadows.
Amianthium, Gray,	Fly poison.		
*A. muscætoxicum, Gray,			Open woods.
Helonias, L.			
*H. angustifolia, Mich.,			Fort Smith.
Chamælirium, Willd.,	Devil's Bit.		
*C. luteum, Gray,			Low grounds.
Tofieldia, Huds.,	False Asphodel.		
T. glabra, Nutt.,			Prairies.
? T. pubens, Ait.,		Sandy,	Barrens.

Juncaceæ. *Rush Family.*

Luzula, D C,	Wood Rush.		
L. campestris, D C.,			Rocky woods.
Juncus, L.,	Rush.		
J. effusus, L.,			Ditches.
*J. setaceus, Rost,			Nutt. Cat.
*J. scirpoides, Lam.,			Borders of streams.
*J. acuminatus, Mich.,			Bogs and ponds.
*J. heteranthos, Nutt.,			Woods.
*J. repens, Mich.,			Nutt. Cat.
J. tenuis, Willd.,			Prairies.
*J. bufonius, L.,			Low grounds.

Pontederiaceæ. *Pickerel-weed Family.*

Pontederia, L.,	Pickerel weed.		
P. cordata, L.,			Shallow water.
Heteranthera, Ruiz.			
*H. limosa, Vahl.,			Nutt. Cat.
Schollera, Schreb.,	Water Star-grass.		
S. graminea, Willd.,	"		Shallow streams.

Commelinaceæ. *Spiderwort Family.*

Commelyna, Dill.,	Day flower.		
*C. communis, L.,		Alluvial,	Low ground.
*C. erecta, L.,		"	Shaded banks.
*C. Virginica, L.,			Damp rich woods.
Tradescantia, L.,	Spiderwort.		
*T. Virginica, L.,			Moist woods.
*T. rosea, Vent.,		Sandy,	Woods and banks.

Cyperaceæ. *Sedge Family.*

Cyperus, L.,	Galingale.		
C. flavescens, L.,		Sandy,	Banks.
C. diandrus, Torr.,		"	" Wet places.
*C. Nuttallii, Tor.,		"	" "

LATIN NAMES.	ENGLISH NAMES.	GEOLOG'L STATION.	NATURAL HABITAT.
C. strigosus, L.,		Limestone,	Creeks and bottoms.
C. inflexus, Muhl.,		Sandy,	Banks and gravel.
C. ovularis, Tor.,		"	Woods. Dry places.
*C. retrofractus, Tor.,			Marshy ground.
Kyllingia, L.			
K. pumila, Mich,		Limestone,	Creeks and banks.
Eleocharis, R. Br.,	Spike-Rush.		
*E. quadrangulata, R. Br.,		Sand,	Nutt. Cat.
*E. palustris, R. Br.,			Low ground. Ditches.
E. acicularis, R. Br.,			Brooks. Mammoth Spring.
*E. pygmæa, Torr.,			Marshes.
Scirpus, L.,	Bulrush.		
S. pungens, Vahl.,		Gravelly,	Banks of White River.
*S. lacustris, L.,			Ponds.
Fimbristylis, Vahl.			
F. autumnalis, Roem.,		Sandy,	Banks of Arkansas River.
Fuirena, Rott.,	Umbrella-grass.		
F. squarrosa, Mich.,		Limestone,	Springs, mossy ground.
Rhynchospora, Vahl.,	Beak-Rush.		
*R. alba, Vahl.,[1]			Nutt. Cat.
*R. longirostris, Nutt.,			" "
Scleria, L.,	Nut-Rush.		
*S. reticularis, Mich.,		Sandy,	Swamps.
Carex, L.,[2]	Sedge.		
*C. rosea., Schk.,			Moist woods.
*C. plantaginea, Lam.,			Shady woods.
*C. anceps, L.,			Rocky woods.
*C. flava, L.,			Wet meadows.
*C. tentaculata, Muhl.,			" "
*C. folliculata, L.,[3]			Peat bogs.
*C. lupulina, Muhl.,			Swamps.

Gramineæ. *Grass Family.*

Greenia, Nutt.			
*G. Arkansana, Nutt.,		Limestone,	Hills of Red River.
Leersia, Sol.,	False rice.		
L. oryzoides, Sw.,	Rice Cut-grass,		Wet meadows. Mammoth [Spring.
*L. Virginica, Willd.,	White grass.		
Zizania, Gron.,	Indian rice.		
Z. aquatica, L.,[4]	Water oats,		Swamps, &c. Mam. Spring.
*Z. miliacea, Mich.,			" "

[1] Though this species is enumerated in Nuttall's Catalogue, I doubt that it belongs to Arkansas.

[2] Of this genus, which in the Southern States contains seventy-five species at least, M. Nuttall mentions only seven species in his catalogue, with this remark: "*and many others.*" As late in the autumn, when I visited Arkansas, the species of this genus have entirely disappeared, the catalogue is of course incomplete for the genus Carex. Most of the species enumerated in Chapman's Southern Flora belong also to Arkansas. I have copied only the short list of M. Nuttall.

[3] Rather a Northern species. Can scarcely be found in Arkansas.

[4] Appears rare in Arkansas. It is greedily eaten by cattle, but generally grows in too deep water. Its grain is gathered by the Indians and used for food.

Latin Names.	English Names.	Geolog'l Station.	Natural Habitat.
Alopecurus, L.			
*A. geniculatus, L.,			Moist meadows.
Vilfa, Ad.,	Rush-grass.		
*V. aspera, Beauv.,		Sandy,	Fields.
V. vaginæflora, Torr.,		"	Barren.
Sporobolus, R. Br.			
? S. Indicus, Brown,			Wet places.
Agrostis, L.,	Bent grass.		
*A. perennans, Tuck.,			Damp shaded places.
*A. scabra, Willd.,		Sandy,	Dry places.
*A. vulgaris, With.,[1]	Red-top grass,		Meadows.
*A. arachnoides, Ell.,			High prairies.
Polypogon, Desf.,	Beard-grass.		
*P. racemosum, Nutt.,			Nutt. Cat.
Cinna, L.,	Wood reed-grass.		
*C. arundinacea, L.,			Damp woods.
Muhlenbergia, Schreb.,	Drop-seed grass.		
M. Mexicana, Trin.,			Low ground.
M. diffusa, Schreb.,		Sandy,	Hills and woods.
Calamagrostis, Adan.,	Reed Bent grass.		
C. Canadensis, Beau.,		"	Shady banks.
*C. gigantea, Nutt.,		"	Banks of Salt River.
Stipa, L.,	Feather grass.		
*S. sericea, Mich,			Nutt. Cat.
*S. parviflora, Mich.,			" "
*S. avenacea, L.,		Sandy,	Woods.
Aristida, L.,	Triple-awned grass.		
A. gracilis, Ell.,		Sandstone,	Prairies and hills.
*A. dichotoma, Mich.,			Old fields.
A. stricta, Mich.,		Sandy,	Prairies.
*A. oligantha, Mich.,			Nutt. Cat.
*A. pallens, Nutt.,			" "
*A. purpurea, Nutt.,		Sandy,	Plains of Red River.
A. tuberculosa, Nutt.,		"	Prairies.
Spartina, Schr.,	Cord or Marsh grass.		
*S. cynosuroides, Willd.,			Banks of rivers.
*S. polystachya, Willd.,		Sandy,	Brackish marshes.
Ctenium, Panz.,	Toothache grass.		
*C. Americanum, Spr.,		Sand,	Barrens.
Bouteloua, Lag.,	Muskit grass.		
B. curtipendula, Gray,		Limestone,	Hills and barrens.
*B. oligostachya, T. & Gr.,			Nutt. Cat.
Cynodon, Rich.,	Bermuda grass.		
C. Dactylon, Pers.,			Dry fields. (Introdu·
Eleusine, Gært.,	Crab grass.		
E. Indica, Gært.,			Waste places. "

[1] This species is often cultivated on wet meadows. It is known also under the name of Bent grass. The name of Herd grass, which it bears also sometimes, belongs to *Phleum pratense*. The white Bent grass, *Agrostis alba*, L., was formerly celebrated under the name of Tiorin grass. It is not better grass than this. The hay of the Red top is good, but short and thin.

Latin Names.	English Names.	Geolog'l Station.	Natural Habitat.
Leptochloa, Beauv.			
*L. fascicularis, Gray;			Wet meadows.
*L. attenuata, Nutt.,			Nutt. Cat.
Tricuspis, Beauv.			
T. seslerioides, Torr.,		Sandy,	Prairies.
*T. stricta, ? Nutt.,			" Nutt. Cat.
Diarrhena, Raf.			
D. Americana, Beauv.		Limestone,	Rich banks of rivers.
Koeleria, Pers.			
*K. cristata, Pers.,		Sandy,	Hills.
Eatonia, Raf.			
*E. obtusata, Gray,			Dry soil.
Melica, L.,	Melic grass.		
*M. mutica, Walt.,			Nutt. Cat.
Glyceria, R. Br,	Manna grass.		
*G. nervata, Trin.,			Moist meadows.
*G. fluitans, R. Br.,			Shallow water.
Poa, L.,	Meadow grass.		
*P. pratensis, L.,[1]			Fields. Cultivated.
P. annua, L.,	Low spear grass.		Waste grounds.
*P. nemoralis, L.,			Nutt. Cat.
*P. interrupta, Nutt.,			Bushy prairies.
*P. capitata, Nutt.,[2]		Sandy,	Banks.
Eragrostis, Beauv.			
E. reptans, Nees.,		Sand,	"
*E. poæoides, Beauv.,		"	"
*E. pilosa, Beauv.,		"	"
*E. tenuis, Gray,		"	"
*E. capillaris, Nees.,		"	Fields.
*E. pectinacea, Gray,		"	"
*E. conferta, Prin.,		"	Banks.
Festuca, L.,	Fescue grass[3]		
*F. tenella, Willd.,		Sandy,	Sterile places.
*F. polystachya, Mich,			Nutt. Cat.
*F. diandra, Nutt.,			" "
*F. sciurea, Nutt.,			" "
F. elatior, L.,			Cultivated fields.
Bromus, L.,	Brome grass.		
B. ciliatus, L.,		Limestone,	Banks of King's River.

[1] This is the common meadow grass generally cultivated. It grows more or less luxuriantly, according to the richness of the soil, and makes better hay when mixed with other grasses, especially the tall Fescue. The Blue grass (*Poa compressa*) is also cultivated, and often mixed with the meadow grass. The Blue grass is better adapted for dry sandy soil than the former, and by its creeping roots would be valuable especially on the prairies of Arkansas.

[2] Nuttall says that this species is allied to *Poa reptans*, and thus would go with the next genus. Probably the former also.

[3] Two species of Fescues. *Festuca elatior*, the tall Fescue, and *Festuca pratensis*, Hud., the Meadow Fescue, scarcely distinguishable in their form, are generally cultivated for hay. A rich, friable, wet soil is the best for these species.

Latin Names.	English Names.	Geolog'l Station.	Natural Habitat.
Uniola, L.,	Spike grass.		
*U. multiflora, Nutt.,		Sand,	Banks of Arkansas River.
*U. gracilis, Mich.,		Sandy,	Prairies.
Phragmites, Trin.,	Reed.		
P. communis, Pur.,			Wet prairies (rare).
Arundinaria, Mich.,	Cane.		
A. macrosperma, Mich.,		Alluvial,	Rich banks. Bottoms.
*A. pumila, Nutt.,			Red River.
Lepturus, R. Br.			
L. paniculatus, Nutt.,			Open ground.
Hordeum, L.,	Barley.		
H. pusillum, Nutt.,			Saline soil.
Elymus, L.,	Lyme grass.		
E. Virginicus, L.,		Limestone,	Barrens & banks of rivers.
*E. Canadensis, L.,			Nutt. Cat.
Uralepis, Nutt.			
*U. aristulata, Nutt.,		Sand,	Banks of Arkansas.
Danthonia, D C,	Wild Oat grass.		
*D. spicata, Beau.,		Limestone,	Rocky places.
Phalaris, L.,	Canary grass.		
*P. occidentalis, Nutt.,			Inundated prairies.
Chloris, Sw.			
*C. verticillata, Nutt.,		Sand,	Banks. Fort Smith.
Paspalum, L.			
*P. purpureum, Ell.,			Nutt. Cat.
*P. racemosum, Nutt.,			Red River. Plains.
*P. stoloniferum, Nutt.,			Arkansas. (Nutt. Cat.)
P. setaceum, Mich.,		Sandy,	Fields.
P. læve, Mich.,		"	Moist grounds.
Panicum, L.,	Panic grass.		
*P. gibbum, Ell.,			Swamps.
P. hians, Ell.,		Sand,	Low ground.
*P. sanguinale, L.,	Common crab-grass,		Waste grounds.
P. anceps, Mich.,		Sandstone,	Barrens.
*P. agrostoides, Spreng.,			Wet meadows.
*P. capillare, L.,		Sandy,	Plains.
*P. virgatum, L.,			Moist soil.
P. clandestinum, L.,		Limestone,	Woody banks.
*P. microcarpum, Muhl.,			Thickets.
*P. pauciflorum, Ell,			Wet meadows.
*P. dichotomum, L,			Common.
*P. verrucosum, Muhl.,			Swamps.
*P. ignoratum, Kunth.,			Nutt. Cat.
P. Crus-galli, L.,	Barn-yard grass,		Waste places.
Setaria, Beauv.,[1]	Fox-tail grass.		
S. glauca, Beauv.,	Bottle grass,	Sandy,	Open places. Everywhere.

[1] The Bengal grass (*Setaria Italica*, L.), and the Hungarian grass (*Setaria Germanica*, Var.), are cultivated everywhere for hay. They may do well on the drained prairies of Arkansas. Still, on the same land, oats and barley are more valuable.

Latin Names.	English Names.	Geolog'l Station.	Natural Habitat.
Orthopogon, R. Br.			
*O. parvifolius, Nutt.,			Nutt. Cat.
Cenchrus, L.,	Burr grass.		
*C. tribuloides, L.,			Sandy banks.
Rottboellia, R. Br.			
*R. campestris, Nutt.,			Plains of Red River.
Tripsacum, L.,	Gama grass.		
*T. dactyloides, L.,			Moist soil.
Erianthus, Mich.,	Yellow Beard grass.		
*E. alopecuroides, Ell.,		Sandstone,	Barrens.
Andropogon, L.,	Beard grass.		
A. furcatus, Muhl.,			Dry prairies.
A. scoparius, Mich.,			" "
A. Virginicus, L.,		Sand and clay,	" "
*A. macrourus, Mich.,		"	Low ground.
*A. filiforme, Nutt.,			Shrubby plains.
*A. ambiguum, Mich.,			Open woods. Cadron R.
Sorghum, Pers.,	Broom Corn.		
S. nutans, Gray,[1]		Sandy,	Dry prairies.

Equisetaceæ. *Horsetail Family.*

Equisetum, L.,	Horsetail.		
E. hyemale, L.,[2]		Sand,	Banks of the rivers.

Filices. *Ferns.*

Polypodium, L.			
P. vulgare, L.,		Sandstone,	Shady rocks.
P. incanum, Willd.,			On trees and rocks.
Allosorus, Bern.,	Rock brake.		
A. atropurpureus, Gray,		Limestone,	Rocks.
Pteris, L.,	Brake.		
P. aquilina, L.,			Rocky hills and prairies.
Adiantum, L.,	Maiden hair.		
A. pedatum, L.,			Shaded rocks. Rich woods.
A. capillus-Veneris, L.,		Limestone,	Rocks near springs.
Cheilanthes, Swartz,	Lop fern.		
C. vestita, Willd.,		Sand,	Rocks.
C. tomentosa, Link.,		"	Rocky ridges.
C. Alabamensis, Kuntz.,		Limestone,	Hot springs.
Woodwardia, Smith.			
*W. Virginica, Willd.,			Swamps.
Camptosorus, Link.,	Walking leaf.		
C. rhizophyllus, Link.,			Shaded mossy rocks.

[1] So hard and siliceous is this species, and also the Beard-grass species, that their culms are not destroyed by the fires of the prairies

[2] Used for scouring.

LATIN NAMES.	ENGLISH NAMES.	GEOLOG'L STATION.	NATURAL HABITAT.
Asplenium, L.,	Spleenwort.		
A. pinnatifidum, Nutt,		Limestone,	Cliffs.
A. Ruta-muraria, L.,		"	"
A. Trichomanes, L.,			Shaded cliffs.
A. ebeneum, Ait.,		Sandstone,	Rocky woods.
*A. angustifolium, Mich.,			Rich woods.
*A. Filix-foemina, R. Br.,			Moist woods.
Woodsia, R. Br.			
? W. obtusa, T.,[1]		Limestone,	Cliffs.
Cystopteris, Bernh.,	Bladder fern.		
C. fragilis, Bernh.,		Sandstone,	Shady rocks.
Aspidium, Swartz,	Wood fern.		
A. Thelypteris, Sw.,			Marshes.
A. spinulosum, Sw.,			Woods.
A. cristatum, Sw.,			Swamps and woods.
*A. marginale, Sw.,			Hillsides. Rocky woods.
*A. acrostichoides, Sw.,			"
Onoclea, L.			
? O. sensibilis,	Sensitive fern.		Wet shady places.
Osmunda, L.,	Flowering fern.		
O. spectabilis, Willd.,			Marshy woods.
*O. cinnamomea, L.,			Springs near banks of Arkansas River.
Botrychium, Sw.,	Moonwort.		
*B. lunarioides, Sw.,		Alluvial,	Deep rich woods.
*B. obliquum, Muhl.,		"	" "
? B. Virginicum, Sw.,		"	" "
Ophioglossum, L.			
*O. vulgatum, L.,			Wet woods. Rich soil.

Lycopodiaceæ. *Club Moss Family.*

Selaginella, Beauv.			
S. apus, Sp.,		Sandy & clayish,	Wet ground.
S. rupestris, Spring,		Sandstone,	Dry rocky places.
Azolla, Lam.			
*A. Caroliniana, Willd.,			Floating. Pools.
Marsilea, L.			
*M. mucronata, Willd.,			" "

[1] I have seen it in the southern part of Illinois on the Mississippi River, but not in Arkansas.

CRETACEOUS FOSSILS OF ARKANSAS.

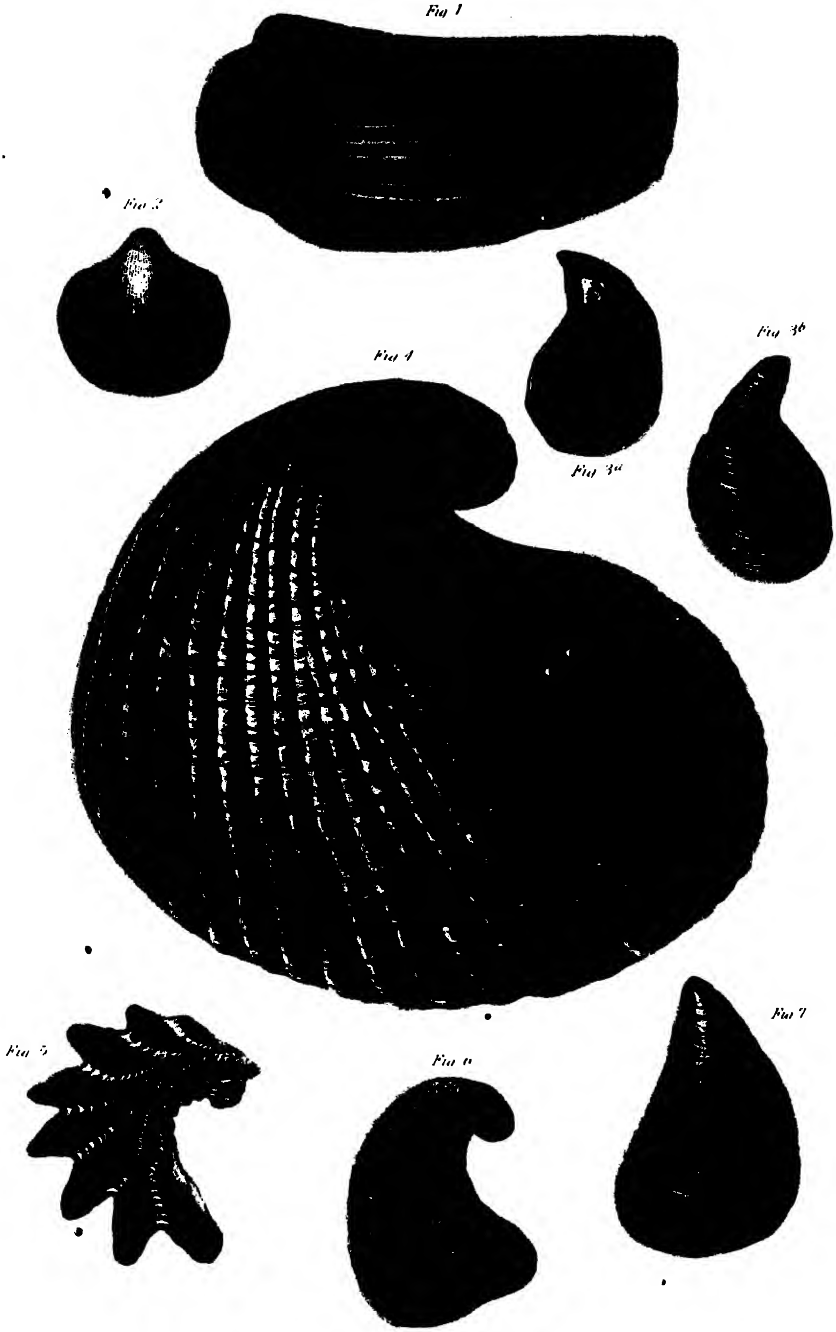

Fig. 1. Inoceramus sp. undt. Fig. 2. Cardium. Fig. 3a. 3b. Ostrea cretacea, Morton. Fig 4. Exogyra costata, Say. Fig. 5 Ostrea falcata, Morton. Fig 6. Gryphaea Pitcheri, Morton. Fig. 7. Ostrea cretacea ? Morton

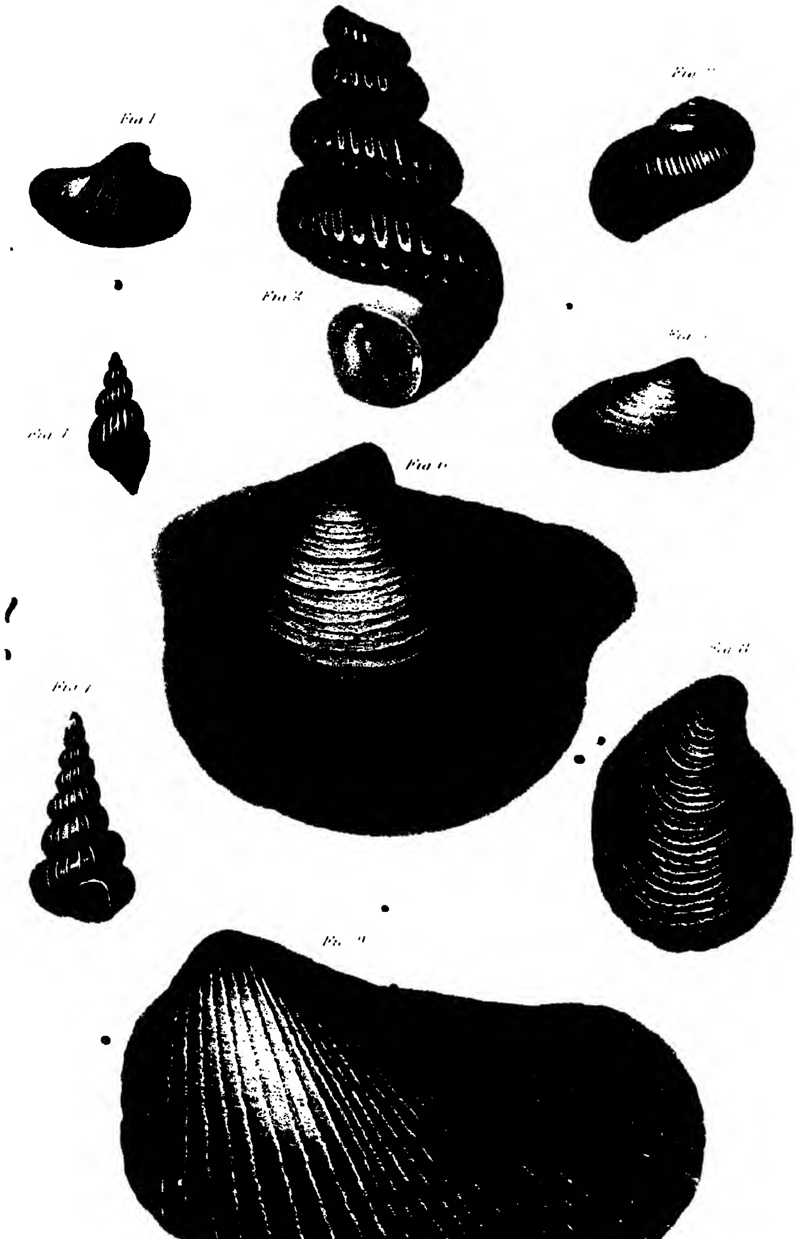

Fig. 1. Corbula sp. undt. Fig. 2. Turrilites sp. undt. Fig. 3. Natica sp. undt. Fig. 4. Fusus sp. undt. Fig. 5. Crassatella sp. undt. Fig. 6. Ostrea vesicularis, Lam. Gryphaea mutabilis, Morton. Fig. 7. Scalaria Sillimani ? Morton. Fig. 8. Ostrea cretacea ? Morton. Fig. 9. Pholadomya occidentalis, Morton.

TERTIARY FOSSILS
OF
ARKANSAS.

EOCENE. PLATE IX

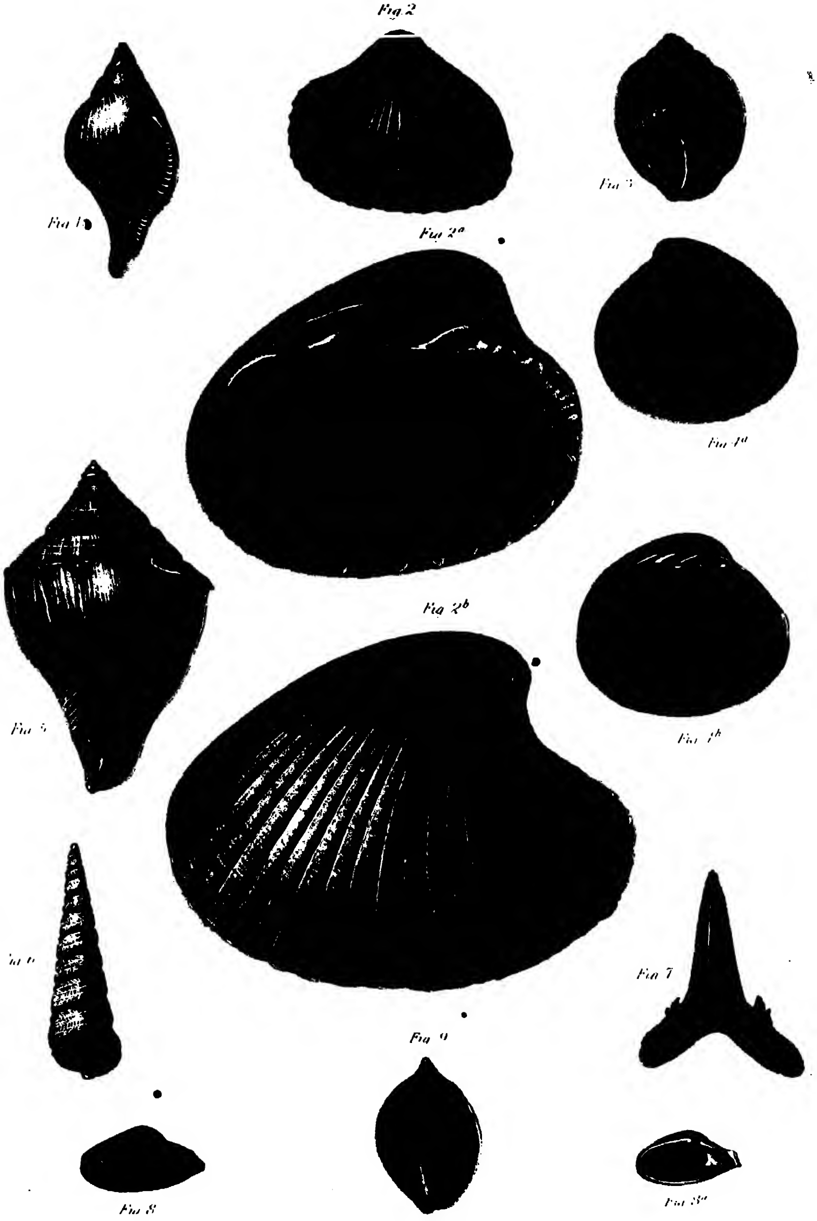

Fig. 1. Fusus. Fig. 2, 2a, 2b, Venericardia planicosta, Lam. Fig. 3. Monoceros vetustus, Lea. Fig. 4a, 4b, Cytherea sp. undt. Fig. 5. Voluta sp. undt. Fig. 6. Turritella plebeia, Say. Fig. 7. Lamna sp. undt. Fig. 8. Corbula Alabamenses, Lea. Fig. 9. Ancillaria subglobosa, Lea.

SECOND REPORT

OF A

GEOLOGICAL RECONNOISSANCE

OF A PART OF THE

STATE OF ARKANSAS,

MADE DURING THE YEARS 1859 AND 1860.

BY

EDWARD T. COX,
ASSISTANT GEOLOGIST.

INTRODUCTION.

It was not until after my return from the State of Arkansas to New Harmony, on the 26th of November, 1860, that the sad news of the death of the State Geologist, David Dale Owen, which had only reached me through the papers on the day of departure from Little Rock, was ascertained to be too true. Though for a long time in feeble health, and suffering from excruciating pains in his limbs and chest, he remained constantly at his favorite occupation,—arranging the material for the second Geological Report on Arkansas,—calmly contending with his increasing physical weakness. And when no longer able to use the pen himself, he was propped up in a chair, and continued to dictate his report up to within three days of his death. Such indefatigable energy and unswerving devotion to the cause of science can seldom be found, and in his death Geology has lost one of its hardest workers and most able expounders.

For eight years I have been his student and constant companion, both in the field and chemical laboratory, and the interest which he manifested in my progress has forever rendered him dear to my memory; and it is in this, his final report, I wish to record this feeble testimony of my high esteem.

For the greater part of the last two years, in prosecuting the Geological Survey of Arkansas, I was attached to Dr. Owen's corps in the field, and as I had personally examined but a small district of country not previously reported upon, Dr. Owen had kindly consented to incorporate my notes in his report, which, on my departure for Arkansas in October last, had been left with him for that purpose; but his untimely death prevented its accomplishment, and I am now compelled to write them out in as rapid a manner as possible, the printing having been necessarily delayed beyond the allotted time. This, I trust, will serve as an apology for the brevity of my report.

REPORT.

In the fall of 1859 I accompanied Professor Leo Lesquereux in an excursion through a portion of the northern, middle, and southeastern counties, for the purpose of establishing the position and extent of the coal-field of Arkansas, and noting its Flora.

An account of this important work, performed by Professor Lesquereux, will be found detailed in his able report; and I have only to add a few memoranda connected with the geology of those parts of the country passed through, which he has not mentioned, or to which he has only briefly alluded.

As we were to enter the State at a point near the Mammoth Spring in Fulton county,—a description of which is given in the first Geological Report, accompanied by a plate representing a faithful view of this locality, sketched by Dr. D. D. Owen,—and as there was some doubt in regard to the geological position of the rocks through which this great spring makes its way to the surface, I was requested to pay particular attention to the subject. This I did; and although the rocks are entirely destitute of fossils, I feel confident, from the lithological character and order of superposition, that they belong to the Lower Silurian age.

The water of the Mammoth Spring was found to have an alkaline reaction, which became remarkably strong when reduced by evaporation to one-half its original bulk. In the water thus concentrated, there was also found, in addition to what has already been reported, a trace of chlorine, sulphuric acid, and iron.

In the southwestern part of Newton county, on Section 16, and 35 or 36, Township 16 north, Range 23 west, on the waters of Buffalo river, a considerable amount of digging has been done for lead, and some 18,000 or 20,000 pounds of the ore have been taken out. Great excitement prevailed about this discovery of ore, and all the land in the vicinity was immediately entered. It is thought, however, that the richest deposits exist on the 16th Section. At Clark's diggings, where the ore has been principally mined, the lead is represented as lying in pockets or crevices in the rocks, and not in regular veins. This is the condition in which the ore is also found at Granby, in Jasper county, Missouri, the richest lead

mines in the West. Not only from the manner in which the ore occurs in the rocks of Newton county does it resemble the Granby mines, but it also has the same geological horizon, and is accompanied by the same association of minerals.

The specimen of lead sent to the laboratory, by George Lewis, to be examined for silver, from Fayetteville, Washington county, was from Newton county. Unfortunately, he did not state the exact locality from which it came; otherwise, a region thus rendered interesting, would have been thoroughly examined. As it was, we did not even learn the abundance of lead raised at these mines, until it was impossible to spare the time necessary to visit them. From what is known of the surrounding country, and the information obtained from those who have been at the mines, there is every reason to believe that valuable deposits of ore will be found in this county.

It is a fact worthy the special attention of those residing in the northern counties of Arkansas, that there is every probability of finding valuable deposits or veins of lead in the following counties: Randolph, Lawrence, Independence, Izard, Searcy, Marion, Carroll, Newton, Madison, Benton, and Washington. The occurrence of lead was already noticed in the former report. Since the publication of that report, however, it has been ascertained that granite makes its appearance at the mouth of Spavinaw creek, in the Cherokee country, some thirty or forty miles west of the Arkansas line; and the probability is, that this granite underlies the lead-bearing rocks in the northwestern counties of this State, and the southwestern counties of Missouri. A favorable bottom-rock is thus formed on which the ore may collect, thus giving plausibility to the opinion, that in some localities, by pursuing the irregular surface-lode of lead down to this granite, ore may be found in paying quantities.

The following is a statement of the analysis of the lead ores from Newton county.

No. 1. Specimen obtained from Hon. W. W. Watkins.

500 grains of ore gave:

Metallic Lead, ...	390 grains	=	78 per cent.	
Globule of Silver, ...	0.0008 "	=	.00016 per cent.	

5.25 oz. Silver to ton of ore.

No. 2. Specimen sent by George Lewis, of Fayetteville.

Metallic Lead, ...	350 grains	=	70 per cent.
Globule of Silver, ...	0.0005 "	=	.0001 per cent.

3.27 oz. of Silver to the ton.

No. 3. A clear, bright specimen, gave:

Metallic Lead, ... 400 grains = 80 per cent.
Silver equal 1.30 oz. to ton.

Accompanied by the Hon. W. W. Watkins, I visited the locality near Carrollton, in Carroll county, where Mr. Childers had been digging for copper ore. It was a wild, romantic spot, in a deep recess of the Childers' mountain, at the base of a massy, pebbly conglomerate. A horizontal drift had been made into the pyritiferous shale for many feet, and several boxes of iron pyrites, which had been mistaken for copper, were taken out, and left to decompose under the influence of the atmosphere. The main body of the iron pyrites is found in a marl about fifteen inches thick, in which I saw imperfect specimens of carboniferous fossils. This sulphuret of iron might readily be mistaken by the inexperienced for the more valuable ore—copper pyrites—which it greatly resembles, and from which it may be distinguished by its greater hardness.

The following is the order of superposition of the rocks from Long creek to the top of Childers' mountain. The thickness of the members is only approximate.

Conglomerate, ferruginous at the top,—some good surface iron ore, but mostly iron sand,—heavy bedded and full of pebbles,	200 to 300 feet.
Pyritiferous marl, with carboniferous fossils mostly imperfect, among which could be distinguished T. Serpentes, . .	15 inches.
Pyritiferous, argillaceous shale, with three bands of clay iron-stone, in all 4 inches, ...	7 feet.
Sandstone and shale, ...	100 ? feet.
Subcarboniferous sandstone, ...	200 ? feet.
Subcarboniferous limestone.	
Chert.	
Subcarboniferous limestone with Chert.	
Bed of Long creek.	

The pyritiferous marl will make an excellent fertilizer, and though it is impracticable to wagon it from this locality, it may be found at the same geological level in situations where it is possible to get it without much expense.

Soils for chemical analysis were collected from the Rev. Josiah Childers' farm, on Long creek, adjoining the town of Carrollton. In good seasons this land will produce sixty bushels of corn, or twenty bushels of wheat to the acre; and is excellent for oats, rye, timothy, Hungarian, and herd grass. The old field has been twenty years in cultivation, and was one of the first settled places in the county. The soil is derived from the conglo-

merate and sandstones on one side, and the subcarboniferous limestone on the other.

The following is a qualitative chemical examination of the water of Long creek, at Carrollton, in Carroll county.

It is alkaline to test paper, and contains principally,

Bicarbonate of Lime,	strong.
" " Magnesia,	moderate.
Sulphate " "	"
" " Soda,	"
Chloride of Sodium,	small.

In the northwestern corner of Carroll county there is an iron forge known as the "Old Beecher forge." It is situated on Osage creek, and is driven by the water of that stream. The main ore worked at this forge is obtained on Mr. C. B. Whiteley's land, on Sections 24 and 25, Township 20, Range 24. The ore is scattered through this part of the county generally in deposits of small extent. At the above localities, however, it is reported to have a depth of three feet.

Iron ore is found in many places around Berryville, and a small deposit is crossed by the road leading from that town to the forge. Situated in the midst of a beautiful agricultural district, and surrounded by an abundance of good ore, there is every reason to believe that, if properly managed, this forge may be worked with profit to the owner, and prove a source of convenience to the community at large; as iron shipped to this remote region has a long land carriage, which makes it command a high price. Last spring, when this forge was in operation, two hundred pounds of good bar iron could be made each day.

On the west bank of Osage creek, at the Beecher forge, there is a bluff of massive magnesian limestone belonging to the lower silurian period. Ascending from this to the headwaters of Keel's creek, in Madison county, we saw the pink and gray marble rock described in the former report, exhibited in great perfection. One slab, which lay across our road, was six inches thick, and from twelve to fifteen feet across in any direction. At this place it could be easily quarried, and obtained in enormous, perfect slabs,—the transportation by wagon, being only ten miles to the mouth of Osage creek, is quite practicable.

This marble rock belongs to the subcarboniferous beds, as we found in it *Spirifer Keokuk* (Hall), and fragments of other carboniferous fossils. The following section represents the rocks forming the divide between War-Eagle and King's river, in Madison county. The height of the ridge, by the barometer, was one thousand feet. As we were travelling on the dip of the strata, the thickness is given approximately:

	Heavy-bedded conglomerate, sandstone, and shales of the millstone grit, ...	400? feet.
Subcarboniferous System.	Subcarboniferous sandstone, with vesicular markings, sometimes fossiliferous, alternating with easily weathering, cherty limestones, ...	300? "
	Cherty, fossiliferous limestone, containing *Orthis Keokuk* (Hall), and *Spirifer Keokuk* (Hall), .	250 "
	Chert bed, with casts of crinoidea,—*Actinocrinus* and *Platycrinus*,—underlaid by the pink and white marble rock, in which we found *Spirifer Keokuk* (Hall), ...	250 "
?	Massive, coarse-grained sandstone, ...	150 "
Devonian System.	White, earthy (hydraulic?) limestone, alternating with greenish, marly shale, the place of water oozings, and forming also the substratum of the prairies in the northwest part of Carroll county, ...	300 "
Lower Silurian.	Roughly weathering, and heavy-bedded magnesian limestone,—upper part alternating with silicious rocks,—lower part, lead-bearing, ...	400 "
	Aggregate, ...	2050 feet.

On the top of this divide, between the waters of War-Eagle and King's river, there is a broad table-land, extending four miles to the southwest, and covered with a luxuriant growth of grass, affording fine pasturage for cattle and sheep. Mr. Vaughan informed us that this land would produce from forty to fifty bushels of corn, or fifteen to twenty bushels of wheat, to the acre, when the season was favorable.

In the extreme northern part of Madison county a small quantity of lead ore has been found, and the country is reported as being remarkably broken.

In Benton county we called to see Dr. S. R. Bell, who lives five miles west of Bentonville. This gentleman had forwarded a lot of mineral specimens to the laboratory at New Harmony, for examination, wishing to know if they contained copper. Though the specimens sent to the laboratory proved to be iron pyrites, it was thought best to visit the locality where it was found; as this mineral, though of but little value itself, is often associated in veins along with copper and other valuable ores.

From Dr. Bell's residence in the edge of Osage prairie, down to the bottom of the shaft which had been sunk in search of ores, we traced the following section:

Yellow schistose sandstone, ...	40 feet.
Black shale, with a species of Lingula, ...	10 "
Productal and Spirifer limestone, schistose limestone; hard Productal Limestone, with disseminated crystals of iron pyrites that had been mistaken for copper pyrites, ...	35 "

A set of soils was collected from this part of the Osage prairie for analysis. The land will produce, on an average, forty bushels of corn, or fifteen bushels of wheat to the acre, or one thousand to fifteen hundred pounds of excellent tobacco. The farmers of North Arkansas are beginning to turn their attention to the culture of tobacco. Last year a tobacco manufactory was established at Bentonville, and turned out six hundred boxes of manufactured tobacco its first year.

Crystals of iron pyrites were also seen at Mr. Rippatoe's on Spavinaw creek at the State line, in a stratum of soft, decomposing limestone.

In order to learn if the red granite, which makes its appearance at the mouth of this stream, in the Cherokee country, some thirty or forty miles from the State line, was to be found in Arkansas, an excursion was made for that purpose, but without the desired result. For thirteen miles along the creek the carboniferous limestone is in place, and from one hundred to two hundred feet thick, without any apparent dip or disturbance, so far as could be seen along our route.

Mr. Hastings, some years ago, quarried a set of millstones out of this granite in the Indian country, which we saw running in a small mill within the State, and obtained specimens of the rock from the fragments broken off in the fashioning.

When at Van Buren, in Crawford county, a mineral was given me by Judge Green, of that city, for examination, which proved to be a fragment of a meteorite, that weighed twenty-two and a half ounces. At the first glance it has the appearance of an igneous rock stained on the exterior with oxide of iron; but on close inspection particles of native iron may be seen projecting out of the mass that are quite sharp to the touch. On making a partial qualitative examination, it was found to contain—

Native iron,	Lime,
Nickel,	Magnesia.
Alumina,	

Along with the malleable iron and nickel there is nepheline and olivine, of a pale and dark green color.

I was also informed by Mr. Scott, of Van Buren, that about noon on the 4th day of July, 1859, while at a barbecue in the northwest part of Crawford county, he saw an aerolite fall. Before reaching the ground it burst into fragments, and made a report as loud as the discharge of a cannon. A portion of the fragments fell in a shower, on the roof of a cabin near Mr. Pennywit's sulphur spring, and another portion some half a mile distant. Mr. Scott had picked up a piece of this meteoric stone, which he presented, a short time before our arrival, to Captain Albert Pike, of Little Rock.

For other remarks on the geology of the western and middle counties, see the First Arkansas Report, and the Reports of Dr. D. D. Owen and Prof. Léo Lesquereux, in the present volume.

At Rockport, in Hot-Spring county, the beautiful novaculite rock, vitreous sandstone, shales, and deposits of milky quartz belonging to the millstone-grit series, terminate on the Wachita river; and to the southeast of this point, between the waters of this stream and the Mississippi,—extending on the north to the Arkansas river and far beyond, the tertiary gravel, sands, and clay, with the exception of occasional beds of limestone, and now and then a capping of quaternary on the highest points, and alluvium in the river and creek bottoms, form the entire surface stratum.

South of Rockport and east of the Wachita river, in Hot-Spring county, the country is generally level, with low ridges, covered with waterworn quartzose pebbles. The soil in the flats is of an ashen color, and the land is, for the most part, wet and spongy.

In the southwest corner of this county, we visited Barkman's salt wells. Good, substantial works have been built at this place for making salt; but no pains were taken to stop out the fresh water from the wells, nor was proper search instituted for deeper-seated and stronger brines; consequently, the works were left idle, and are rapidly going to decay. The shallow wells, from which the brine was used, are about one hundred and fifty yards from the works, situated on a flat that was covered with standing water at the time of our visit. Water taken from one of the wells, though mixed with much fresh water from the recent heavy rains, gave a large percentage of chloride of sodium (common salt), a large quantity of magnesia and lime, a small quantity of carbonic acid, a trace of iron, and a feeble alkaline reaction.

Not far from these wells, there is a bayou called "Salt Lake," which, with the Wachita river, forms a small island called "Salt Island." The water in this lake is made brackish by the salt springs which break out along its shore. The springs were covered by the water of the lake when we were there; so there was no possible chance of obtaining a fair sample of the salt water at these works.

Mr. Barkman, the proprietor, was not at home; but directions were given to have brine sent to the laboratory for analysis, when it could be properly collected. His attention was also called to the fact, that he would be able to strike brine in a well sunk immediately at the works, and thus save the expense of a long string of pipes, and a useless waste of power; that the fresh water should be stopped out by tubing; and that the probable existence of a stronger brine, at a greater depth, should by all means be tested.

One mile from Arkadelphia, on the Princeton road, in Dallas county, we visited salt wells owned by B. G. Harley & Co., of Princeton. These

wells, like those owned by Mr. Barkman only a few miles distant, in Hot-Spring county, were filled with fresh water by the overflowing of the creek, near the bed of which they were sunk; consequently, no analysis of the brine could be made on the spot. Mr. Harley promised to have the water collected at a suitable time, and sent to the laboratory.

About ten years ago, these wells were extensively worked by Mr. Easly. We called at the residence of this gentleman, who now lives in Hot-Spring county, for the purpose of ascertaining the quantity of brine it required to make a bushel of salt, and found that he was absent from home; consequently, we were unable to learn any particulars connected with the old works.

From the geological features of the country, and a large number of saline springs in the vicinity, there is every reason to believe that here, as well as at Barkman's, an abundant supply of brine may be found on going deeper. The experiment will cost but a small sum, and is well worth the trial.

Salt could be conveniently shipped in boats from Arkadelphia to the Southern market, thereby insuring a flourishing trade.

Where the road leading from Arkadelphia to Princeton crosses the Ouachita bottom, which is here some five miles in width, the soil is a stiff, ash-colored clay. After leaving this bottom, we ascended to gravel ridges, which form the leading features in the western and northern parts of Dallas county.

About twelve miles from the river, we saw a bed of hard, calcareous rock, full of tubular markings, resembling somewhat a species of *siliquaria*. Its position appeared to be under the ferruginous conglomerate and sandy iron ore, at the base of the gravel-bed.

On Little Cypress creek, one mile west of Mr. Watson's, in Township 7 south, Range 17 west, we saw two beds of lignite, one above the other. This lignite is of a good quality, and has associated with it an excellent plastic clay, suitable for making stoneware.

The position of the lignite is given below in a general section of all the strata seen in Dallas county, all of which belong to the tertiary.

Water-worn pebbles, or gravel-bed; the gravel sometimes cemented by iron into a ferruginous conglomerate,* . . .	15 feet.
Place of silicified wood (fossil trees), ...	0.
Red, sandy clay, sometimes containing good iron ore, sandy iron ore, and ferruginous sandstone, the latter often much fluted; thickness variable, from	10 to 40 feet.
Light-colored sand, ...	80 feet.

* This gravel-bed is at the base of the Quaternary, and forms a junction between that series and the Tertiary. It has been a question of some doubt to which division it should belong. My own observations favor the opinion that it should be placed with the Tertiary.

Upper lignite bed, ...	1 to 2 feet.
Ash-colored sandy clay, ...	12 feet.
Plastic potter's clay, ...	3 feet.
Lower lignite, bed of Cypress creek; more compact and of better quality than the bed above; thickness could not be accurately measured, as it lay in the bed of the creek, ...	3 feet.

Lignite is found in many places in the northern part of Dallas county, especially on Big Cypress and on the Saline river, in the northeast corner of the county, near the Hot-Spring county-line.

At the village of Tulip, which is built on the gravel-bed, petrified trees have been found in digging wells, at a depth of twenty or thirty feet. Fragments of this fossil wood, that had been thrown out of the wells, were picked up in the streets. We also saw the petrified stump of a tree in the southeastern corner of the county, on Mr. Council's land, Section 36, Township 10 south, Range 13 west. The gravel-bed lay above it in the ridge.

Ten or twelve miles south of Princeton, on the Camden road, there is a heavy-bedded, coarse-grained, dark-colored, ferruginous sandstone, which is quarried and used for under-pinning houses, walling up wells, &c. One block of this rock, which had been prized up, measured ten inches by thirty. In a country where bedded rock is so scarce, this sandstone becomes of considerable value to the inhabitants.

There are four main characters of cultivated land in this county: gravel land, sandy land, red clay land more or less sandy, and the black bottom land on the creeks. The three first varieties will yield about eight hundred pounds of cotton to the acre, and the creek bottoms about one thousand pounds. The soils collected for analysis from this county have not yet been analyzed.

At Mrs. Helena Mattocks, eight miles west of Princeton, the water of a spring, which was supposed to be unwholesome, was examined, and found to contain:

Bicarbonate of Lime, ...	a small quantity.
" " Magnesia, ...	" "
Chloride of Sodium, ...	" "
Sulphate of Magnesia, ...	" "
" " Soda, ...	" "

This water was neutral to test-paper, and had a slight odor of sulphuretted hydrogen, though none could be detected in the water by acetate of lead. Its character is that of a weak saline sulphuret, and from the small amount of mineral matter which it contains, cannot be considered unhealthy.

Bradley county, north of Range 11, is similar in its geological fea-

tures to the northern part of Dallas, being broken by low ridges, which are, for the most part, covered with gravel. In this county our examinations were suddenly stopped by intensely cold weather, which, setting in after a heavy rain and sleet, made the roads so slippery with ice, that it was impossible to travel.

I feel under many obligations to Judge J. M. Merriwether, at Mt. Elba, who kindly gave us entertainment until we were able to make our way to Pine Bluff. While at Judge Merriwether's, we collected characteristic soils of the Saline river bottom, from his plantation, Section 8, Township 10, Range 10. The soil is usually of a dark color, sometimes black,—the latter being considered the least productive. The subsoil is a yellow, tenacious clay, one to one and a half feet beneath the soil.

A qualitative analysis was made of a well-water at this place, and the principal constituents were found to be:

Bicarbonate of Lime,	remarkably strong.
" " Magnesia,	" "
Sulphate of Alumina,	strong.
" " Magnesia,	"
" " Soda,	"
Chloride of Sodium,	"
Iron,	a trace.

The water is acid to test-paper, and when evaporated to dryness, leaves a large residuum. It is so strongly charged with mineral matter that it is entirely unsuited for domestic use. Even cattle and other stock would probably be greatly injured, if suffered habitually to drink this water.

PHILLIPS COUNTY.

Crowley's ridge, which runs through Greene, Craighead, Poinsett, and St. Francis counties, forming the divide between the waters of the St. Francis and White river, terminates in Phillips county just below the city of Helena. The top of this ridge, throughout its entire extent in Arkansas, is composed, for the most part, of silicious clay and marl of quaternary date, usually resting on a bed of waterworn gravel. Numerous springs of good, cool water, flow from beneath this gravel-bed along the eastern foot of the ridge, near Helena. There is a prevalent opinion among the residents, that this water, if drank during the summer season, will invariably produce sickness. On this account, it was thought advisable to test the water from three of the principal springs, which were found to be so nearly alike in their properties, that the analysis of one, given below, will answer for all. The most noted is the "Big Spring," three miles above Helena,

which forms a considerable stream where it flows from under the gravel-bed, at the base of the ridge. On examination, the principal constitutents of this water were found to be:

Carbonic Acid,	strong.
Lime,	"
Magnesia,	"
Iron,	a trace.

Saturated with sulphuretted hydrogen, this water gave no indication, either in an acid or alkaline solution, of any metal except a trace of iron. Therefore, it is not likely to contain any mineral poison; and though strongly charged with bicarbonate of lime and magnesia, it is not probable that these ingredients are particularly injurious in water; except it be to those who are suffering from calculus. Nevertheless, there is a deserted cabin close by, of which it is said that all those who occupied it and used the water from the "Big Spring," either died, or were taken sick and had to move away. As a general rule, when sickness comes upon us, we are all prone to look for the cause outside of our own transgressions against the laws of nature. For my part, I should rather attribute the cause of the sickness which befell the occupants of the cabin at "Big Spring," to their own imprudent habits, and the miasmata arising from a large swamp close by, than to the use of the clear, cool water of the spring, sparkling with its surcharge of carbonic acid.

The following section, showing the position of the material composing Crowley's ridge, was taken close to Mr. Rightor's dwelling in the edge of the city of Helena.

Quaternary.	Yellow, silicious clay,	6 feet.
	Marl, with fossil shells.	
	At this place, the marl was traversed by two vertical cracks one inch in width, and filled with sand from the stratum beneath.	
Tertiary.	Yellow and orange sand, and gravel,	20 feet.
	Gravel,	6 inches.
	Space concealed—reddish clay?	9 feet.
	Plastic clay (potter's), local,	6 inches.
	Yellowish and white sand, with some gravel,	5 feet.
	Sand and gravel,	15 "
	Space concealed,	12 "
	Bed of slough,	0

The counterpart of Crowley's ridge may be seen on the opposite side of the Mississippi river, at Memphis; thence running northward through the State of Tennessee and a part of Kentucky, crossing the Ohio river at

Caledonia in Illinois. In Tennessee, this ridge reaches the river at the first, second, third, and fourth Chickasaw bluffs. In Kentucky, at Hickman, Columbus, and Jefferson's bluff. The fourth Chickasaw bluff, upon which Memphis is built, has an elevation of some seventy feet above low water, and is entirely composed of yellowish, marly clay, belonging to the quaternary. At Randolph, on the second Chickasaw bluff, the elevation is two hundred feet above low water, and for the sake of comparison, the following section obtained at that place is here given:

Quaternary.	Sandy soil and subsoil, ...	85 feet.
	Yellowish marly clay, ...	
Tertiary.	Purplish-pink clay,*	6 inches.
	Yellowish sand and gravel, ...	10 feet.
	Brown, silicious, and lignitic clay shale,† .	20 "
	Upper bed of lignite, ...	2 "
	Ash-colored clay with fossil leaves, . .	11 "
	Lower bed of lignite, ...	2 feet 6 inches.
	Space,—ash-colored silicious clay?—to low water of Mississippi river, ...	70 feet.
	Aggregate, ...	201 "

The yellow sand and gravel-bed, at the junction of the Quaternary and Tertiary, is very variable in its character, but marks a distinct horizon through a district of country many miles in width; and, so far as known, extends in length from the southern part of Arkansas, running with a northeasterly strike through the eastern part of that State, the western part of Mississippi, Tennessee, Kentucky, and terminating in the southern part of Illinois. It is this member, cemented into a hard, ferruginous conglomerate, which crosses the Ohio river at New Caledonia in Illinois, and forms the Grand and Little chain on that stream.

In Phillips county, there are many remains of old fortifications or aboriginal towns to be seen,—monuments of a bygone race, of whose history no tradition known to the white man has been preserved by the occupants of the country. One of these ancient works of art, four miles west of Helena, at the terminus of Crowley's ridge, was visited. The embankments, now nearly destroyed by the washing of the rains, and the cultivation of a part of the land, were built of sun-dried clay, mixed with stems and leaves of the cane. The vegetable structure of the cane is still well preserved in the clay matrix, and I could, in no instance, find any evidence of the cane's having been charred by fire: hence the conclusion, that it received no greater drying heat than that given it by the sun. Nor is

* Increases to ten feet a short distance below the town.

† Probably the same that is called "black dirt" in Bradley and Ashley counties, Arkansas.

there any appearance of fashioned brick, of which it is said this wall was built. The clay and stems of cane appear to have been mixed together and moulded into a wall, somewhat after the manner of a pisé. The northern boundary of this enclosure is formed by the hills, and within the interior there are a number of small mounds.

Old Town, fifteen miles below Helena, on the Mississippi river, derives its name from the evidence afforded of its having been the site of an aboriginal village.

In an agricultural point of view, Phillips county ranks equal to any in the State. The broad Mississippi bottom in the southern part, interspersed with small, old river lakes and bayous, is remarkably fertile, and under a high state of cultivation. In the western part, watered by Big creek, there is a large body of level land, formed by the gradual flattening out of Crowley's ridge in that direction: hence it has received the name of "table land." Farther to the west, extending to Cache river and beyond, the country is traversed by low ridges, with intervening clay flats, and occasional wet prairies. The ridges have, for the most part, a reddish, sandy clay soil,—occasionally a gray sandy loam.

Characteristic soils were collected for analysis from the Mississippi bottom, at Mr. Cooper's plantation, six miles south of Helena. One set was taken from a ridge called "Sugar-tree ridge," on account of the trees of that name which grow upon it. This ridge is elevated a few feet above the overflow of the Mississippi river, and occupies a considerable district, which lies in an elbow formed by Long lake. The fact of sugar trees growing upon this land, rather led me to suspect a more than usual amount of lime in the soil, as this tree is supposed to be partial to a calcareous land, and from report, it is not found anywhere else in the bottom. Besides sugar trees, the principal growth noted consisted of large black walnut, red oak, persimmon, white and red elm, sweet gum, mulberry, large sassafras, papaw, and grape vines. There was also a circle of holly trees, supposed, from their regularity, to have been planted by the aborigines; more especially, as there is a row of them extending in a direct line to the river. Traces of an old fortification are found in this land, together with an abundance of mounds. In the latter, by ploughing up the ground, there have been found human bones, implements of pottery, arrow-heads, and stone axes. One of these axes,—in the possession of Mr. Cooper,—was made from silicified wood, such as we found in Dallas, Jefferson, St. Francis, and other counties. The analysis of the soils from this "Sugar-tree ridge" will be found in Dr. Robert Peter's Report, Nos. 439, 440, 441.

Another set of soils was collected at Mr. Cooper's, from what is known as the "Buckshot land" of Phillips county. This is the low bottom land of lakes and sloughs, from ten to fifteen feet lower than the ridge land. It is a bluish-black, stiff, plastic soil, when wet, and the virgin soil breaks

up under the plough in large cakes, that soon crumble from the action of the atmosphere into small pieces somewhat resembling buckshot, thus becoming mellow and easy of tillage. Mr. Cooper is of the opinion that this character of soil is the most productive in the county. One bale of cotton, or fifty to seventy bushels of corn, may be raised on an acre. The principal growth is large cottonwood, buttonwood, blue ash, occasionally large over-cup oak, and mulberry. For the analysis of the above soils, see Dr. Robert Peter's Report, Nos. 436, 437, 438.

The alluvial land immediately adjoining the Mississippi river is a sandy loam, easily cultivated, and very fertile, producing one bale of cotton to the acre. A characteristic soil was taken from General Pillow's plantation, below Helena. The analysis is given in Dr. Robert Peter's Report, No. 448.

Hill-land soil was collected from William Calvert's farm, on Crowley's ridge. This soil is derived from the silicious, marly, quaternary clay, above the gravel. It stands the drought well, and produces from forty to forty-five bushels of corn, or twenty to thirty bushels of wheat, to the acre. The amount of wheat reported appears to be large; but this ridge is universally spoken of as being excellent for wheat. The principal growth is large poplar (the only poplar trees found in the State grow on this ridge), beech, red oak, Spanish oak, white oak, hickory, sweet gum, black walnut, butternut, sugar-tree, honey-locust, and originally cane. For the analysis, see Dr. Peter's Report, Nos. 445, 446, 447.

The table-land of this county has, for the most part, a deep yellow, or mulatto soil, with now and then small spots of an ashen color, probably the former beds of small, dried-up ponds. These spots are thought to be the most productive. This table-land will produce on an average one thousand pounds of cotton, twenty-five to thirty bushels of corn, or twenty bushels of wheat, and is considered excellent for rye and oats. The principal growth is sweet gum; but on the most elevated portion of this land, at Mr. Rice's plantation, where the soils for analysis were collected, the growth is beech, poplar, red and white elm, mulberry, sweet gum, ash, white oak, black walnut, dogwood, sassafras, and red maple. For the analysis of this soil, see Dr. Peter's Report, Nos. 442, 443, 444.

A PART OF MONROE COUNTY.

The eastern part of Monroe county is somewhat similar in its character to the table-land of Phillips county; but it is diminished in elevation, and becomes more cut up by sloughs and flats, and occasionally by a wet prairie.

In the northeast corner of Monroe are the Big and Little prairies. The latter appears to have been the bed of a dried-up swamp. The soil and

subsoil in this prairie are an ash-colored clay, charged with small iron gravel, having a depth of two to two and a half feet, and resting on a substratum of red clay, which could be seen in the bottom of a ditch recently cut for the purpose of reclaiming the land and bringing it into cultivation. Samples of the soil and substratum of yellow clay were collected from this prairie, and the analysis will be found in Dr. Peter's Report, Nos. 433, 434, 435.

Not far from the Little prairie, and near Moro post-office, soils were collected from Mr. Hall's plantation, the analyses of which are given in Dr. Peter's Report, Nos. 430, 431, 432. At Mr. Hall's the principal growth is white oak, red oak, post oak, hickory, dogwood, sassafras, and some sweet gum.

The soils collected from Alfred Mullen's plantation, near Clarendon, and mentioned in the First Report, have been analyzed, and are given in Dr. Peter's Report, Nos. 297, 298, 299.

ST. FRANCIS COUNTY.

St. Francis county extends from the St. Francis river on the east to White river on the west, and is traversed by Cache and L'Anguille rivers. Crowley's ridge, which runs along the St. Francis river in nearly a north and south course, is here much broken into hills, and has a breadth of from two to six miles, and an elevation of from one hundred and fifty to two hundred feet. The remainder of the county is characterized by low, sandy, and clay ridges, with intervening flat, clay land. The latter is for the most part wet and spouty, and, without drainage, unfit for cultivation: the former is amongst the best cultivated lands of the county.

One and a half miles from Madison, on Crow creek, there is a valuable bed of shell marl. This marl is on property belonging to W. J. Conner, and is for the most part composed of large oyster-shells in a friable condition. Some of these shells were as much as fifteen inches in length, but so easily broken that we found it impossible to get them out whole. Besides the oyster-shells, we collected *Venericardia planicosta* (Lam.), *Monoceros vetustus* (Lea), *Ancillaria subglobosa* (Lea), and *Corbula Alabamiensis* (Lea), proving the deposit to belong to the eocene division of the tertiary. The following is a section of the bluff above the shell marl:

Quaternary,	Silicious, clay marl,	84 feet.
Tertiary,	Gravel, and orange-colored sand,	6 "
	Whitish sand, brown clay at bottom,	10 "
	Oyster bed, with a variety of eocene fossils,	11 "
	Stiff, blue clay, to bed of creek,	4 "
	Aggregate,	511 "

An analysis was made of this shell-marl from Crow creek, and the composition found to be as follows:

Moisture, dried at 300°,	05.20
Insoluble Silicates,	43.40
Carbonic Acid,	18.96
Lime,	24.24
Magnesia,	00.36
Iron and Alumina,	04.80
Phosphoric Acid,[1]	00.37
Sulphuric Acid,	00.85
Chlorine,	00.07
Chloride of Alkalies,	00.15
Loss,	01.66
	200.00

At Mr. Connor's, this shell-marl is but a few yards from the railroad, and the facility with which it may be obtained and transported to various parts of the country, will eventually give it commercial importance, and prove a source of revenue to the owner. It will be found highly beneficial as a mineral fertilizer on the stiff, wet clay lands, so abundant in this and the adjoining counties, as well as for all those fields which have been worn out by improvident cultivation.

Four or five miles north of Madison, on the Wittsburg road, there is a great slide in the ridge, affording a fine view of the strata. The succession was found to be:

Quaternary. Yellowish, silicious, marly clay,	60 to 80 feet.
Red sand and gravel,	30 to 40 "
Gravel-bed,	20 "
Orange-colored sand, containing silicified trees,	10 to 15 "
Branded layers of clay and sand,	6 "
Aggregate,	161 "

Here we had an excellent opportunity of seeing in place the petrified wood, as there was a silicified tree, ten inches in diameter, sticking out of the bank, and exposing about two feet of its length. At a few paces distance, it might have been taken for a half-decayed log, but on striking it with the hammer, its flinty, fossil character, was made manifest.

The following is a section of Copperas bluff, two miles north of Wittsburg:

Yellowish, silicious, marly clay,	42 feet.
Orange sand and clay,	5 to 15 "
" " with gravel,	20 "

[1] The phosphoric acid was estimated with bismuth according to Chaucel's process, and I believe it does not give enough.

Segregations of silicious iron ore, and some fossil wood converted into iron ore, ...	0.
Pale greenish-gray sand, ...	12 feet.
Dirt-bed, with some lignite, fossil leaves and stems, and wood converted into sulphuret of iron, ...	6 "
Ash-colored sand, with segregations of good iron ore resting on clay, ...	12 "
Dirt-bed, with fossil leaves and lignite, and other vegetable remains, partly converted into sulphuret of iron, ...	
Bed of creek.	

The upper iron ore bed in this section is the place of the petrified wood, and we saw the stump of a tree, two feet in diameter, that had tumbled down into the creek. The main body was converted into sulphuret of iron,—the outer surface being oxydized by exposure to the atmosphere.

Selenite and copperas are both found at this bluff; the latter in considerable quantity.

On descending the hill, immediately before entering Wittsburg, there is a bed of silicious iron ore under the gravel-bed, near Mr. Knight's store. Some small beds of good iron ore were also seen on the hillsides, along the road from Wittsburg to Dr. Van Patten's, and it is probable that enough may be found to run a small Catlin forge.

The spring-water at Wittsburg was examined, and found to contain a small amount of—

Chloride of Sodium,	Bicarbonate of Magnesia.
Bicarbonate of Lime,	

It flows from under the gravel-bed, and is very pure, wholesome water.

A set of soils was collected on the west side of Crowley's ridge, from Gov. Mark W. Izzard's plantation, adjoining the old town of Mount Vernon. The principal growth on this land is Black Hickory, Sweet Gum, Poplar, Black Ash, Elm, Sassafras, Dogwood, and Box Elder. The soil from the old field has been thirty years in cultivation, and would still produce, per acre, a bale of cotton, forty to fifty bushels of corn, or fifteen bushels of wheat. It is also good for oats, red-top, and timothy. For the analysis of these soils, see Dr. Peter's Report, Nos. 449, 450, 451.

The following comprise the analyses of springs, not before noted, in Poinsett county.

An examination of Dr. Van Patten's spring, two miles south of Walnut Camp, showed the principal ingredients to be:

Bicarbonate of Lime, ...	a small quantity.
" " Iron, ...	" "
" " Magnesia, ...	" "
Sulphates, ...	a trace.

This is a very weak chalybeate, and can hardly be said to have medicinal properties.

John England's well-water, one and a half miles south of Harrisburg, was also analyzed. The water was found in white sand, below the gravel-bed, at a depth of nineteen feet from the surface. The principal constituents are:

Free Sulphuretted Hydrogen, . .	a trace.
Sulphate of Magnesia,	
" " Soda,	
Chloride of Sodium,	
Bicarbonate of Lime,	
" " Magnesia.	

This is an alkaline, saline, sulphuretted water, and has excellent medicinal properties.

In conclusion, I wish to call attention to the topographical and geological map of the Fourche Cove district, near Little Rock, in Pulaski county, constructed by Mr. Joseph Lesley, in accordance with instructions received from the State Geologist. This map is designed to show the manner in which the detailed work is to be prosecuted. Not only does it present the topographical character of the country, showing the elevations of the ridges, courses of the smallest rivulets, positions of farms, &c. &c., but its most important feature consists in the accuracy with which the geology may be represented, the valuable metalliferous ores located, and their extent and importance made known. Such a map of the State, when completed, will correct the present incomplete and imperfect geography of the country, and leave nothing more to be desired in a geological point of view.

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